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Comparison of Upper Arm Measurements by Use of Roentgenogram and Anthropometric Techniques[1]

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Abstract

This research was undertaken to study those aspects of the upper left arm that could be readily differentiated by roentgenogram and anthropometric measures. High correlations were obtained between girth by tape and width by roentgenogram (0.95), between girth and width of muscle and bone (0.82), and between pinch caliper and roentgenogram width of adipose tissue (0.79). Low correlations resulted between adipose tissue measurements and girth and width of the upper arm.

A HIGH RELATIONSHIP between the flexed-tensed upper arm and several strength test variables and arm strength criteria has been reported by Clarke (1). Among the correlations were the following: 0.74 with McCloy's arm strength score; 0.52 with MacCurdy's pulling strength test; and 0.47 with shoulder extension strength by cable-tension method. The subjects utilized in the study were male physical education majors. They were dominantly mesomorphic with some tendency toward ecto-mesomorphy; and had better than average musculatures. Thus, the amount of adipose tissue was relatively slight for most of the subjects.

The anthropometric tape in measuring girth, obviously, must include all aspects of the arm: bone, muscle, blood vessels, fat, and skin. The present research was undertaken to study those aspects of the upper left arm that could be readily differentiated by roentgenogram and anthropometric measures and to determine their inter-relationships. The study may logically contribute techniques for measuring muscle mass and adipose tissue of the upper arm for use in further research relative to the volitional strength and endurance of human muscles.

Anthropometric Testing Techniques

Anthropometric measures in this study were taken to determine the girth and the amount of adipose tissue over the biceps muscle of the upper left arm. The measurement techniques utilized are given below.

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[1]Appreciation is expressed to the Graduate School, University of Oregon, for subsidization of this study.

UPPER-ARM GIRTH

A correlation of 0.89 was reported by Clarke (1) between the girths of the upper arm when relaxed and tensed. As a consequence of this high relationship, the only girth measurement taken in this study was of the flexed-tensed upper arm. The testing technique utilized was formerly used by Crowell, Gëser, Noonan, and Stephens (2), as follows:

The subject was in an erect sitting position with both feet flat on the floor. The left elbow was flexed to 90 degrees with the forearm supine. The fist was clinched vigorously so as to bunch the biceps muscle. The measurement was taken around the most prominent part of the upper arm with a cloth tape to which was attached a Gulick handle. In order to control the amount of pressure exerted on the soft tissue in making this measurement, the spring in the Gulick handle was pulled to the same position each time.

SUBCUTANEOUS TISSUE

A pinch caliper was used to measure the amount of adipose tissue, plus skin, over the biceps muscle. The technique used for this test is described by McCloy and Young (4) as follows: The measurement was taken directly over the biceps muscle midway of its length with the arm in an extended-relaxed position. A double layer of skin was grasped between the thumb and forefinger and held loosely as the caliper was applied some two to four millimeters above the ends of the thumb and finger. The spring of the caliper was released and the caliper was pressed against the fold of skin to prevent the skin from slipping back to its natural position. Care was taken not to pull the skin away from the arm.

Subject Placement for Roentgenograms

Roentgenograms were taken with the upper left arm in two positions: one with the arm flexed but relaxed; and the other with the arm flexed and tensed. The position of the subjects for each of these positions is described below.

Flexed-relaxed position. The placement of the subjects in the flexed-relaxed position is shown in Figure I and was as follows:

1. The subject was seated with the upper arm resting on the base of the X-ray machine, which had been mounted on a table.
2. The film holder was placed under the arm so that the total width of the arm and as much of the humerus as possible were included on the film. The position of the holder was marked with strips of adhesive on the base of the X-ray machine to facilitate film placement each time a roentgenogram was taken. The adhesive tape can be seen in Figure II.
3. The subject's arm was flexed to about 90 degrees and the upper arm was held parallel to the film holder. A small block of wood was placed under the arm near the elbow to keep the soft tissue of the arm from pressing against the surface of the holder.
4. The X-ray machine was faced downward toward the subject's arm with the tube centered directly over the broadest part of the upper arm.

FIGURE I. Position of Subject for Taking Roentgenogram with Flexed-Relaxed Upper Arm.

Flexed-tensed position. The placement of the subjects for taking roentgenograms with the arm in the flexed-tensed position is illustrated in Figure II and was as follows:

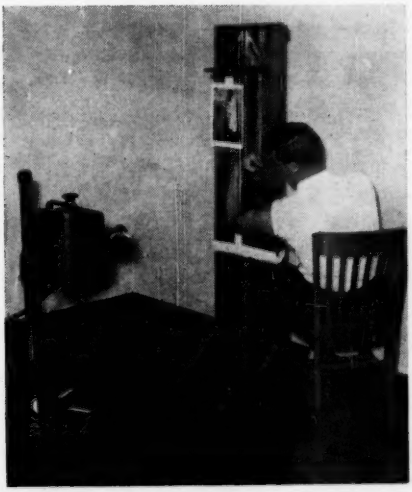

FIGURE II. Position of Subject for Taking Roentgenogram with Flexed-Tensed Upper Arm.

1. Two narrow strips of board were shaped and nailed together to form a groove about the thickness and width of the film holder. This contrivance was fastened with tape to a wide perpendicular board at a height convenient to the subject when seated in a chair. A short upright strip was erected to serve as a stopper for the holder when in place and to provide a rest for the medial epicondyle of the arm.
2. The subject was seated in a chair so that the upper left arm would bisect the cardboard holder and be parallel to it. The medial epicondyle was rested on the short upright strip in such a way as to avoid the exertion of pressure on the soft tissue of the arm.
3. The subject's arm was flexed to a little more than 90 degrees so that when the muscle was tensed the forearm would form an approximate right angle with the upper arm. The position of the upper arm itself was the same as when the girth measurement was taken.
4. The X-ray machine was faced directly toward the perpendicular board so that the tube of the X-ray was centered on the broadest part of the tensed upper arm.

Roentgenogram Specifications[2]

After experimentation with the available X-ray machine the following specifications were found satisfactory for taking roentgenograms for the necessary soft-tissue analysis needed for the study:

1. Type of X-ray machine: "Profexray" Portable X-ray Machine, manufactured by the Professional Equipment Company, Maywood, Illinois.
2. Size of film: 8 x 10 inches, although a larger size might well have been better.
3. Type of film exposure holder: cardboard holder.
4. Focal distance: 30 inches from cardboard holder.
5. Amperage: 15 milliamperes.
6. Voltage: 103 volts.
7. Exposure time: one second.
8. Developing process: four minutes in the developer and at least eight minutes in the fixer; wash for 30 minutes; and hang on racks until dry.

Roentgenogram Measurements

The roentgenogram was placed on a table-top viewer. The following three measurements were made with a transparent ruler calibrated in millimeters: (a) total width of the upper arm, (b) width of muscle and bone, and (c) width of adipose tissue and skin over the biceps muscle. These measurements were taken at the widest point of the upper arm and were made perpendicular to the humerous. The widest point of the upper arm is usually at the insertion of the deltoid muscle on the humerus. This insertion could easily be distinguished on the roentgenogram. The unit of measurement was to the nearest millimeter.

Results

The subjects were 30 freshman male students at the University of Oregon, selected at random. In treating the data, Pearson's product-moment coeffi-

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[2]Precautions were taken to control well within safety limits the X-ray dosage to which subjects and testers were subjected. Each X-ray was of mild intensity; and only two X-rays were taken of each subject. The tester was approximately 15 to 20 feet from the subject at each exposure.

cients of correlation were computed to show the following relationships: test-retest reliability for certain of the measurements; and intercorrelations of anthropometric and roentgenogram tests. In interpreting the intercorrelations, r's of 0.36 and 0.45 are statistically significant at the .05 and .01 levels of confidence respectively (3).

RELIABILITY COEFFICIENTS

Anthropometric tests. Test-retest reliability was not determined for the girth measurement of the flexed-tensed upper arm. A high objectivity coefficient for this test had previously been reported (2). Gëser, who had developed this technique, took the actual measurements utilized in the present study.

A reliability coefficient was obtained for the pinch-caliper technique of measuring the amount of adipose tissue and skin over the biceps muscle. With one day between tests, the 30 subjects were tested twice by the same tester. The coefficient of correlation between the tests was 0.98.

Roentgenogram tests. As indicated above, three measurements were made on the roentgenograms for both relaxed and tensed positions, as follows: width of muscle and bone, thickness of adipose tissue and skin, and total width of the upper arm. The test-retest reliability by the same tester for each of these measurements was determined both by repetition of the measurements on the same roentgenograms and by making the measurements on two roentgenograms of the same subject taken several weeks apart. The coefficients of correlation from these repeated tests appear in Table 1.

TABLE 1

Reliability Coefficients for the Roentgenogram Measurements of the Flexed Upper Arm of College Men

Widths	Same Roentgenogram		Different Roentgenograms	
	Relaxed	Tensed	Relaxed	Tensed
Muscle and bone	0.996	0.97	0.82	0.95
Adipose tissue and skin over biceps	0.99	0.96	0.95	0.92
Total width of upper arm	0.99	0.99	0.87	0.97

The reliability coefficients for the three measurements repeated on the same roentgenogram for both the relaxed and tensed positions were all very high, ranging from 0.96 to 0.996. When different roentgenograms were used, the reliability coefficients were between 0.92 and 0.97 when the upper arm was tensed. However, in the relaxed state, the coefficient for muscle and bone width dropped to 0.82, which probably accounts for the coefficient of 0.87 for width of the total arm.

INTERCORRELATIONS

In studying the interrelationships of the various variables included in this study, the first step was to correlate the scores obtained in the relaxed and

tensed positions for each of the three roentgenogram measurements. The results were as follows:

Width of muscle and bone	0.85
Width of adipose tissue and skin over biceps muscle	0.95
Width of total upper arm	0.87

As these correlations were as high as could be expected from the test-retest reliability coefficients reported above, it was considered unnecessary to continue in this research with measurements of both the tensed and relaxed positions. The tensed position was chosen in each instance for further study, since the highest reliability coefficients from separate roentgenograms were obtained for these measurements (Table 1). The intercorrelations for the remaining five anthropometric and roentgenogram measurements appear in Table 2.

TABLE 2

Intercorrelations of Anthropometric and Roentgenogram Measurements of the Flexed Upper Arm of College Men

Measure	Anthropometric		Roentgenogram		
	Pinch Caliper	Girth	Muscle and Bone	Adipose and Skin	Total Width
Pinch caliper		0.36	0.03	0.79	0.37
Girth			0.82	0.54	0.95
Muscle and bone width				0.11	0.90
Adipose tissue & skin width					0.49

The following observations may be made relative to the intercorrelations of the various anthropometric and roentgenogram measurements of the left upper arm:

1. The correlation of 0.95 between the girth of the upper arm by anthropometric tape and the total width by roentgenogram measurement was so high as to justify the use of either for testing purposes. Similar high correlations were obtained by Reynolds (5) for the lower leg, as follows: 0.92 for children 7½ years of age; and 0.97 for the same children at 10½ years of age.

2. The width of muscle and bone was the primary determinant in the total width of the flexed-tensed upper arm, as shown by the correlation of 0.90.

3. The girth of the upper arm by anthropometric tape had a high relationship with the width of muscle and bone from the roentgenogram. This correlation of 0.82, however, indicates that other factors than muscle and bone enter into the girth measurement. Difference in the amount of adipose tissue among the subjects is probably the primary factor in this situation.

4. The correlation between the measurements of adipose tissue and skin by pinch caliper and roentgenogram width was 0.79. This correlation is sufficiently low to indicate that the two methods should not be used interchangeably.

5. The correlations of the width of adipose tissue and skin with girth and with total width of the upper arm were 0.54 and 0.49 respectively. These correlations are significant slightly beyond the 0.1 level of confidence. While low, these correlations show a consistency of relationship between similar variables, girth and width of the upper arm.

6. Although the correlations were lower, a similar situation to the above existed for the pinch-caliper method of measuring adipose tissue and skin. The correlation of these measurements with width of the upper arm was 0.37; and with girth, 0.36. These correlations are significant at the .05 level of confidence.

7. The only coefficients which were not statistically significant were the 0.11 and 0.03 obtained when the width of muscle and bone was correlated with the measurement of adipose tissue and skin on the roentgenogram and by pinch caliper respectively.

Conclusions

In this study of anthropometric and roentgenogram measurements of the left upper arm of college freshman male students, high reliability coefficients were found. High correlations were obtained between girth by tape and width by roentgenogram (0.95), between girth and width of muscle and bone (0.82), and between pinch caliper and roentgenogram width of adipose tissue (0.79). Low correlations resulted between adipose tissue measurements and girth and width of the upper arm. The correlation between adipose tissue measurements and width of muscle and bone were far below acceptable significance levels.

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(Submitted 7/23/56)

Comparison of the Effectiveness of Three Methods of Teaching Beginning Bowling

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Abstract

In this study three groups of beginning bowlers were given basic instruction and then completed a ten-game series each group being restricted to using a specified method. The recorded game scores were subsequently analyzed for nine major components comprising favorable and unfavorable features of bowling. On the basis of the results obtained, it was concluded that headpin bowling is superior to spot and combination bowling in teaching beginners. Strikes, spares, splits, and errors did not appear in any significant patterns. Gutter balls were rolled more frequently in the first five frames of the games than the second five.

DURING THE PAST two decades there has been a marked increase in participation and interest in the sport of bowling. A recent booklet by participants in a National Recreation Workshop estimated that 15 million people enjoy the relaxation of bowling each year (1). *Sports Illustrated* ranked bowling as the second most popular participant sport in the nation, being exceeded in total numbers only by fishing (7). Bowling has an exceptionally wide appeal due to its adaptability to all ages and sexes. Many colleges and universities recognizing its recreational advantages are now offering bowling as part of the regular physical education curriculum.

For a recreational sport of such magnitude, there has been a limited amount of research conducted concerning its various phases. In a documentary analysis of the contents of the *Research Quarterly* from 1930-49, Loucks lists one article on bowling among a total of 1,080 articles analyzed (7). This was a study of skill factors concerned with bowling published by Webster in 1940 (12). The next paper concerned with bowling was published in the *Research Quarterly* of 1951 and was a study by Phillips on bowling norms and learning curves for college women(8).

Several theses have concerned themselves with a research problem directed at some aspect of bowling. Of 3,725 Master's theses listed by Cureton in the field of health, physical education, and recreation, four dealt directly with bowling problems (2). These were a study of the effect of bowling on the

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[1]This study was conducted at Texas A. and M. College while the author was a staff member of the Department of Physical Education.

pulse rate by Engel (3); a comparison of learning curves for classes taught by two different methods reported by Hofland (4); a national survey of industrial bowling conducted by Peele (9); and a study of the history and techniques of bowling written by Smith (10).

On occasion, the staffs of the professional magazines connected with bowling have published articles in connection with some of the technical phases of the sport. Hattstrom made a detailed study of the various ways in which the ball rolls (5) and did a form analysis study of the finalists in the 1952 national tournament (6).

Purpose of the Study

The methods now used in teaching bowling in colleges and universities are based primarily on empirical experience. Phillips (8) found that six colleges taught beginners headpin bowling, six taught spot bowling, and nine others used combinations of both methods in their teaching plan. No single approved method of instruction is in vogue.

Bowling has been offered for five years at Texas A. and M. College as part of the regular physical education curriculum. Approximately 500 students a year select this sport as one of their physical education activity courses. The majority of these are beginners who are being introduced to bowling for their first time. With this large number of students concentrating on bowling, it was desirable to base their instruction on the best teaching method in order to achieve reasonable skill in the course of one semester. This experiment was undertaken to determine the following:

1. What are the relative merits of headpin, spot, and combination bowling in teaching beginners?
2. Does a detailed analysis of recorded games show that there is a definite pattern of performance among beginning bowlers?

The second point was important, for if it were found that beginners tended to have a regular pattern of weak and strong frames during their games, this would show where the strongest teaching emphasis should be placed. Concentrated instruction and practice aimed at weak scoring frames would tend to improve the over-all game performance.

Sources of Data

The data for this study were collected during the fall semester of 1953-54 at Texas A. and M. College. It comprises the findings as indicated by the recorded score sheets of 78 beginning students in bowling who completed a carefully regulated ten-game schedule which lasted for six weeks. Once the data were gathered, they were analyzed and presented in graph form for ease of interpretation. In addition to the score sheets, additional data were secured by means of questionnaires, interviews, and observations.

Procedure

A preliminary survey was taken of all students registering for the classes in elementary bowling. One hundred and fifteen indicated that they had never bowled before. These students were then requested to fill out a questionnaire and were interviewed personally to cross check the accuracy of the questionnaire information.

All beginning students then received standard bowling instruction for the next two months. During this time, theory, demonstration, and participation covered such phases as history, rules, etiquette, ball selection, grip, stance, approach, release, and follow-through. Both the straight ball and hook delivery were practiced.

Early sessions consisted of rolling on bare lanes, followed by practice at various single and multiple pin set-ups. Later students bowled up to three frames at full pin set-ups but no complete games were rolled at this stage. Some practice was done against split set-ups.

The proper method of scoring and correct use of bowling terminology were carefully covered and checked by quizzes and having students record actual and theoretical games by the instructor.

The details of the proposed experiment were now explained to the classes of beginning bowlers, and volunteers were requested. A total of 99 students signed up for the experiment. These students were again subjected to a personal interview and questionnaire and the results checked against the information on file from the first contacts. Doubtful cases were then eliminated.

A form study of each participant's individual style was made which covered these 11 features:

1. Grip—right or left handed
2. Starting Stance—erect, semi-crouch, full crouch, other
3. Approach—number of steps, 3, 4, 5, other
4. Speed of approach—fast, medium, slow, varied
5. Type of ball rolled—hook, straight, curve
6. Speed of ball—fast, medium, slow, varied
7. Aiming—pinhead, spot, combination
8. Position of ball at starting stance—chin high, chest high, waist high, knee high, other
9. Side of alley from which approach was made for strike—right, left, middle
10. Position in angle shooting for #7 pin—right, left, middle
11. Position in angle shooting for #10 pin—right, left, middle

The theories of headpin, spot, and combination bowling were explained and demonstrated to these students. Audio-visual assistance in the form of an instructional 16mm film on elementary bowling supplemented the instruction.

Briefly, the headpin or pin sight bowler keeps his eyes focused on the 1-3 pocket during the time he is advancing and releasing the ball. The spot bowler chooses a certain spot on the lane and focuses his attention on this mark as he approaches and delivers the ball. This spot has been so

determined that if he rolls his ball over it correctly it will go into the 1-3 pocket for a theoretical strike hit.

The combination bowler, sometimes called a line bowler, combines both techniques in his endeavors. In combination bowling, the participant in making his approach subsequently checks points at the foul line, a spot on the lane, and finally the 1-3 pocket. He thus has three check points along the way to guide him in delivering the ball. Whereas the headpin bowler concentrates his attention on the pins and the spot bowler on his selected spot, the combination bowler incorporates both in his style of bowling.

Volunteers were permitted to register for either the headpin, spot, or combination groups. In case no preference was expressed, the instructor assigned students to whatever group needed additional members. All participants agreed to the following conditions:

1. They would use the assigned bowling technique of their particular group during the required number of games.
2. They would not bowl outside of the regular bowling classes.

The second stipulation was to eliminate the effect of outside practice. Owing to varying scholastic schedules, it was found impractical to place all volunteers of each method in one class. This would have been highly desirable if it could have been achieved. Members of the three groups were all represented in the same classes. Much good natured rivalry developed among the three groups as to the relative merits of each technique. This informal rivalry caused the students to make certain that individuals in each group stuck to their assigned experimental method.

In order to assist students in adhering to the experiment, frequent verbal reminders were given prior to their turn at bowling. Score sheets were also marked indicating the method assigned. Spotters were placed on the sides of the lanes, out of the direct line of vision of the bowler, to check on the eye focus of the bowler. The shift of eye focus in the three techniques was quite easy to follow. Any unusual deviations were promptly bought to the bowler's attention.

Strips of colored masking tape three inches long by one inch wide were taped on the lanes at the joining boards. These ran parallel with the lane and were placed as assists to the spot and combination bowling groups. They were replaced when necessary.

Classes met twice weekly for 50 minutes each in the local YMCA, which featured a four lane bowling establishment. Every fifth period students were required to set pins. Each participant bowled one game per class period until ten games were registered. These score sheets were filed for future analysis.

The entire experiment was completed in six weeks, the advent of the vacation period making it impractical to carry it further. The spot bowling and combination groups each finished with 26 members. The headpin group completed the experiment with 29 members but later, when data were being analyzed, three of these revealed that they had bowled some extra games

outside of the regular class periods. This necessitated their data being eliminated and the recomputation was on the basis of 26 finalists. Subsequently, this proved to be advantageous as direct comparisons could be made both statistically and graphically.

When all participants had completed the required number of games the individual score sheets for these games were analyzed for the following nine factors:

1. Individual average for ten games.
2. Strikes in each frame.
3. Gutter balls on first ball rolled in each frame.
4. Pins bowled down in each frame on first ball rolled. This also included pins bowled down on strikes.
5. Spares in each frame.
6. Errors in each frame.
7. Splits in each frame.
8. Pins bowled down in each frame on second ball rolled. This included pins bowled down on spares.
9. Total pins bowled down in each frame on first and second ball rolled. This was a summary of numbers 4 and 8.

Results

The following is a composite of the average student who took part in the experiment: age 19 years, used a three-fingered medium weight ball, an erect starting stance with the ball held at waist height, preferred a three or four step approach of medium speed and delivered a straight ball at medium speed. A position on the right-hand side was preferred for making the #7 pin and a left-side alley position for making the #10 pin.

Ten-Game Average. The headpin bowling group had the over-all highest average for the ten-game series with 111.5. The combination group finished a close second with an average of 110. The spot bowler group was well behind with an average of 105 (see Table 1).

Strikes. The combination group scored the highest total for the ten-game series with 320. High strike frames were the 10th, 8th, and 6th frames in that order. The headpin group totalled 319 strikes, with the highest strike frames being the 9th, 7th, and 5th. The spot bowler group totalled 271 strikes during the series, with the 9th, 4th, and 2nd frames showing the highest number (see Table 1).

Gutter Balls. The highest total was that of the spot bowler group with 151 misses. High gutter ball frames were the 1st, 3rd, and 8th frames. The combination group was second in gutter ball total, with 127. High frames were the 7th, 1st, and 2nd. The headpin group scored the least number of gutter balls with a total of 94. High frames were in the 1st, 3rd, and 4th (see Table 2).

Pins Downed on First Ball. The headpin group led with a total of 17,720. High frames in this phase were the 9th, 5th, and 6th respectively. In second place was the combination group with 17,388 pins. High total frames were

the 8th, 10th, and 4th. The spot bowler group finished last in this part of the experiment, with a total of 16,628 pins. High scoring frames were the 4th, 2nd, and 7th.

Spares. The headpin bowler group led in the spare category with a ten-game total of 593. High spare frames were in the 2nd, 4th and 1st. Combination bowlers were a close second, with a total of 587 spares, the three major spare frames being the 8th, 2nd, and 4th. The spot bowler group finished in last place, with a total of 511 spares. High spare frames were the 10th, 8th, and 2nd (see Table 1).

TABLE 1

Group Averages by Games

Type	1	2	3	4	5	6	7	8	9	10	Average
Pin	102	110	109	111	108	116	108	118	117	116	111.5
Spot	95	106	93	104	105	107	109	106	113	113	105
Comb	104	105	104	111	113	115	112	101	114	120	110

Incidence of Strikes by Frames

Type	1	2	3	4	5	6	7	8	9	10	←1st Extra Ball	Total
Pin	26	25	25	35	36	34	36	25	41	31	5	319
Spot	18	30	26	31	28	27	25	24	34	28	5	271
Comb	24	27	30	28	24	35	34	36	32	38	11	320

Incidence of Spares by Frames

Type	1	2	3	4	5	6	7	8	9	10	Total
Pin	61	71	61	63	58	54	58	53	58	56	593
Spot	51	54	47	52	53	53	50	55	40	56	511
Comb	58	65	53	62	58	54	54	66	56	61	587

Pins Downed on Second Ball. The spot bowler group led in total number of pins knocked down on the second ball delivered, with 5,081 pins. Since the spot bowlers took fewest pins on the first ball bowled, this was to be expected. High frames were the 6th, 1st, and 10th. The combination group made a total of 4,948 pins with high frames being the 2nd, 1st, and 7th. The headpin group finished a close third with 4,900 pins. High frames were the 1st, 3rd, and 2nd.

Pins Downed on Both Balls. In total number of pins bowled down on both balls delivered, including pins knocked down on strikes and spares, the headpin group led with a ten-game total of 22,620 pins. High frames were

Errors. First place in the category of total errors for the ten-game series was held by the spot bowler group with a total of 627 errors. High error frames were the 1st, 4th, and 9th. The combination group was second with 592 errors. High error frames were the 3rd, 1st, and 4th. The headpin group made the least total errors with 553. High error frames were the 6th, 8th, and 10th (see Table 2).

Splits. In the undesirable category of splits, the highest total was made by the spot bowlers with 171 splits. High split frames were in the 3rd, 8th, and 9th. The lowest total was by the headpin group which totalled 141. High split frames were the 1st, 4th, and 8th (see Table 2).

TABLE 2

Incidence of Errors by Frames

Type	1	2	3	4	5	6	7	8	9	10	←1st Extra Ball	←2nd Extra Ball	Total
Pin	56	56	57	51	47	61	58	60	48	58	1	1	553
Spot	73	61	59	70	62	54	60	59	67	57		5	627
Comb	66	46	73	63	57	59	58	58	61	51			592

Incidence of Splits by Frames

Type	1	2	3	4	5	6	7	8	9	10	Total
Pin	21	10	12	20	13	10	12	15	15	13	141
Spot	16	17	23	14	17	17	14	23	15	15	171
Comb	15	10	24	13	22	17	12	15	18	17	163

Incidence of Gutter Balls by Frames

Type	1	2	3	4	5	6	7	8	9	10	←1st Extra Ball	Total
Pin	18	10	12	11	5	9	11	6	5	6	1	94
Spot	25	13	18	11	16	11	13	18	13	13		151
Comb	16	15	12	8	12	9	18	8	12	14	3	127

the 5th, 9th, and 6th. The spot bowlers made 21,709 for second place, with high frames being the 2nd, 6th, and 4th. Combination bowlers were a close third, with a 21,701 pin total. High frames for this group were the 10th, 8th, and 3rd.

Discussion

On the basis of the data gathered, headpin bowling appears to be the most effective method in teaching beginners to bowl. The combination method

is almost as good and the rapid rise of the scores of this group in the last few games indicates that it may have been more effective had additional games been bowled in the experiment.

Spot bowling was the poorest of the three methods in teaching beginners. Apparently this is a more advanced technique, which can best be taught after basic bowling fundamentals and skills have been already been learned by one of the other methods. It is definitely the favorite method of the highly skilled bowler, as 15 of 16 finalists in the 1952 national tournament were spot bowlers (6).

The headpin group led in the desirable features of bowling such as strikes, spares, and high number of pins bowled down on the first ball rolled. Spot bowlers were lowest of the three groups in these desirable features but highest intermediate between these two groups in all phases except strikes. In this in the undesirable ones, such as guttering the first ball, splits, errors and low number of pins on first ball delivered. The combination group rated about category they had a slight edge on the headpin group in over-all strike total scoring 320 strikes to 319.

A definite pattern of skill performance does not seem to emerge as far as beginning bowlers are concerned. On strikes there is no significant pattern except the spread from the 2nd to 10th frame. There was a slight tendency to score more strikes in the last five frames but this was not definite enough to establish a skill pattern.

In the matter of spares, the tendency was to score slightly more in the first five frames of the games. However, the minor differences between frames for 1st, 2nd, and 3rd place rank could not be interpreted as being statistically significant.

In terms of total desirable characteristics, the second frames has by far the most frequent placement in 1st, 2nd, or 3rd rank and the 4th and 8th, 3rd and 10th, 5th, 6th, and 7th are equal in frequencies.

Gutter balls definitely decreased in number in the second five frames of the games. An analysis of the three high incidence frames for each group in this phase shows that seven out of these nine frames appeared in the first half of the games. The opening frame ranked 1st at least twice and 2nd once. This fall-off may be due to warm-up effect as the game progresses or better concentration on the part of the bowler. This suggests that the usual practice of rolling one or two balls to warm up for bowling is probably insufficient. A number of frames bowled at a full pin set-up would probably assist materially in reducing the number of gutter balls rolled.

No definite pattern of performance emerged in the category of errors and the appearance of splits. Errors and splits were scattered about equally in the first and second halves of the games. The rank differences and totals were not significant, and no point can be made of them.

Conclusion

Based on the results of this experiment, the following conclusions are made:

1. Headpin bowling is the best method in teaching bowling to beginners. Combination bowling is second best and spot bowling third.
2. Desirable features in bowling, namely strikes, spares and high pin totals on first ball delivered do not appear in a significant pattern.
3. Gutter balls tend to occur more frequently in the first five frames and fall off as the game progresses.
4. Splits and errors do not appear to follow a definite pattern of occurrence.

More attention to pre-game warm up frames is suggested as a means of improving the over-all performance of beginning bowlers.

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Relationship Between Two Motor Educability Tests, a Strength Test, and Wrestling Ability After Eight-Weeks' Instruction

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Abstract

Relationships between two motor educability tests, a strength test, and wrestling ability after eight weeks' instruction were calculated. The unique feature of this study was that none of the 56 college students had ever had any wrestling experience; therefore, they were learning an unfamiliar or new activity. The highest correlation coefficient found was .498 between McCloy's General Strength Quotient and the ability to learn an unfamiliar activity. The individual predictive value of this quotient was of little worth. A battery including two tests of motor educability and a strength test was both impractical and of little worth in predicting individual learning ability of college students in wrestling.

TO BE ABLE to identify students who have the ability to learn new motor skills easily and well is a problem that has perplexed physical educators for many years, McCloy (7) popularized the term "motor educability," revised the Brace Test, and used this Iowa Revision as a measure of motor educability. Brace does not consider his test or the Iowa Revision of his test to be measures of motor educability. He (1) found low coefficients of correlation between tests of general motor educability (made up of "learning tests" of five selected motor activities, and ten motor skills related to swimming) and the Brace and the Iowa-Brace Tests. He (2) also found low correlation coefficients between six learning tests classified as sport type, stunt type, and motor rhythm type and the following "educability" tests: Brace, Iowa-Brace, and McCloy's General Motor Capacity Tests.

Gire and Espenshade (3) conducted a study in which they concluded that Brace, Iowa-Brace, and Johnson Tests of "motor educability" did not measure accurately the ease with which 195 girls in a four-year senior high school in California learned new skills or relearned old ones in basketball, volleyball, and baseball in regular physical education classes. These two writers defined motor educability as the ability to learn *new* skills easily. Since many of the subjects in their study reported previous experience in the game skills tested, the number of inexperienced subjects was not sufficient for a reliable statistical study.

McCloy and Young (9, *pp. 86-87*) mentioned three studies in which relatively high coefficients of correlation were obtained between stunt type

"educability" tests and athletic events and tumbling. The highest correlation coefficient found was .706. Needless to say, a correlation coefficient this large isn't of much worth in individual prediction; it is approximately 30 per cent better than pure "guess." McCloy (7, *p. 51*) realized this fact when he made the following remarks in one of his studies:

". . . much more work needs to be done on these tests, both as to the study of fundamental components of each stunt used, and the selection of scoring and weighting of these stunts, before the best kind of results may be obtained. . . . At present these tests are valuable, but only in a large, rough way."

In the validation of both the Brace and the Iowa-Brace Tests, the criterion was achievement in various motor skills, not ability to learn. Henry and Nelson (5) pointed out the futility of attempting to measure ability to learn by measuring performance level. They stated that learning ability must be tested directly. Henry (4) evolved a method of measuring motor learning by equating his subjects statistically and then calculating how much the individual learner had improved. The relative degree of improvement represented learning rate.

McCloy and Young (9, *pp. 5-11*) listed at least 25 factors in motor educability. They realized (9, *p. 85*) that the present tests of motor educability were inadequate and will probably be replaced by tests devised to measure single factors or sets of related factors.

Purpose of the Study

The purpose of this study was to ascertain the relationships between two motor educability tests, a strength test, and wrestling ability after eight-weeks instruction.

The unique feature of this study was that none of the 56 students had ever received previous wrestling instruction nor had ever had any wrestling experience. In other words, these students had chosen to learn an unfamiliar or new activity. Actually, the writers wanted to ascertain the usefulness of the two best-know tests of "motor educability" in predicting the wrestling ability of students who had had no previous instruction in wrestling or who had never engaged in bona fide wrestling matches.

Selection of Tests

The two measures of motor educability selected were the Iowa Revision of the Brace Test and the Metheny Revision of the Johnson Test. In the revision of the original Brace Test, McCloy (8) claimed an approximate doubling of the validity of this test. In other words, the Iowa-Brace measured, to a greater degree, motor educability, with such factors as strength, size, maturity, and power held constant. All of the 21 stunts found to be of value for predicting motor educability were used in this study (7, *pp. 52-54*).

McCloy and Young (9, *p. 95*) claimed that further studies have indicated the Johnson Test to be, probably, the most valid test of general-motor educa-

bility published to date. The Metheny Revision of the Johnson Test (10) used in this study had a correlation coefficient of .977 with the total Johnson Test.

According to many physical educators, muscular strength is an important factor in achieving success in wrestling. Larson and Yocom (6, *p. 100*) stated, "In those instances where successful performance is in proportion to the amount of muscular strength, then muscular strength tests are valid means of classification for that activity (i.e., wrestling)." They caution, however, that muscular strength tests never yield information on skills or effective utilization of strength. McCloy's General Strength Quotient was selected as the measure of strength to be used in this study.

Procedure

The subjects participating in this study were 56 freshman and sophomore male students enrolled at The Pennsylvania State University in the Required Physical Education Program. None of these subjects were physical education major students and none of them had ever received previous wrestling instruction anywhere nor had had any wrestling experience. The range in age was 17 to 24, inclusive.

All 56 freshman and sophomore students had selected wrestling as the activity in which they wished to participate for the first eight-week session of the second semester during the 1955-56 school year. The 56 students were divided into three classes of approximately 20 students each. Each class met three times a week.

The "motor educability" of the students was measured by the Iowa Revision of the Brace Test and the Metheny Revision of the Johnson Test. The tests were administered by the two junior writers during regular class hours of the first week of the eight-week wrestling course. Scoring of the test items was very strict; precise performance of the exercises was required in the Metheny Revision of the Johnson Test, and proper form in the performance of the stunts in the Iowa-Brace Test was demanded. The students were not permitted to practice the stunts or exercises in these tests beforehand.

The total body strength of the subjects in the study was measured by McCloy's Strength Test. The following measurements were taken by the two junior writers during class hours of the first week of the course: right and left grip strength as measured by a manuometer, back and leg strength as measured by a dynamometer, and arm strength as measured by McCloy's formula (9, *p. 129*). The general-strength quotient for each subject was computed by dividing the unweighted strength score by McCloy's norms for strength according to sex, age, and weight and the multiplication of this value by 100.

A predetermined program of wrestling instruction was carried on for all three classes for the next six weeks of the course by one of the writers of this report who had been a varsity wrestling performer. During this period,

basic skills were taught and developed. Basic maneuvers from the standing and referee's position were emphasized. Actual competition was conducted between the contestants after the first week of instruction.

In an effort to measure each subject's ability to learn wrestling throughout the entire course, the instructor of the three wrestling classes kept copious notes and evaluated each wrestler's ability by means of a predetermined scoring system that used a scale ranging from 0 to 30 points (See Table 1).

TABLE 1

Evaluation of Wrestling Ability

I. WRESTLING ON FEET (Total possible points—9)

A. *Balance:* Wrestler keeps himself well balanced in order to maintain control of his position. Wrestler has his weight equally distributed on the balls of his feet, and does not wrestle flat-footed. Wrestler does not cross his feet; just slides them on the mat and takes very short steps. (Total possible points—3)

B. *Deception:* Wrestler endeavors to deceive opponent; thereby catching him out of position before going for a take-down. (Total possible points—3)

C. *Timing and Speed*: Wrestler takes advantage of opponents' mistakes and moves fast whenever an opportunity presents itself. (Total possible points—3)

II. WRESTLING ON MAT (Total possible points—18)

1. *Top Position* (Total possible points—9)

A. *Weight:* Wrestler keeps his weight well distributed, making opponent carry it. (Total possible points—3)

B. *Balance:* Wrestler keeps himself well balanced in order to maintain control of his position. (Total possible points—3)

C. *Timing and Speed:* Wrestler takes advantage of opponents' mistakes and moves fast whenever an opportunity presents itself. (Total possible points—3)

2. *Bottom Position* (Total possible points—9)

A. *Chain Wrestling:* Wrestler attempts to lure opponent out of position by a series of maneuvers in rapid succession in order to find an opening. (Total possible points—3)

B. *Timing and Speed:* Wrestler takes advantage of opponents' mistakes and moves fast whenever an opportunity presents itself. (Total possible points—3)

C. *Balance:* Wrestler keeps himself well balanced while executing various maneuvers. (Total possible points—3)

III. OVER-ALL WRESTLING ABILITY (Total possible points—30)

A. AGGRESSIVENESS (Total possible points—3)

B. WRESTLING ON FEET (Total possible points—9)

C. WRESTLING ON MAT (Total possible points—18)

SCORING: EXCELLENT—3
GOOD—2
AVERAGE—1
POOR—0

In addition, two competent judges evaluated each wrestler's ability during the last week of the course using the aforementioned wrestler's rating scale. The judges saw each subject wrestle in actual competition for at least three 1½ minute periods. Some objection may be raised as to the use of subjective opinion in determining the ability to learn wrestling. One must remember, however, that many of the so-called objective tests in team and dual sports were validated on the basis of the subjective opinions of experts.

Analysis of Data

Table 2 shows the relationships between Iowa-Brace Test, Metheny Revision of the Johnson Test, McCloy's General Strength Quotient, and Wrestling Ability (how well students have learned an unfamiliar or new activity).

TABLE 2

Relationships Between Measures of "Motor Educability," a Measure of Strength, and a Measure of the Ability to Learn Wrestling

Test	Ability to Learn Wrestling	Metheny Revision of Johnson	P.I.[1]	Iowa Brace	P.I.[1]	McCloy General Strength Quotient	P.I.[1]
Ability to Learn Wrestling	X	.332 ± .12	6%	.459 ± .11	12%	.498 ± .10	14%
Metheny Revision of Johnson				.402 ± .11	9%	.319 ± .12	5%
Iowa-Brace						.273 ± .13	4%
McCloy General Strength Quotient						X	

[1]Predictive Index is an indication of the amount of improvement over pure chance that scores on one variable can be used to predict scores on another variable.
P.I. $= 1 - \sqrt{1-r^2}$.

The highest correlation coefficient found was .498± .10 between the McCloy Strength Test and Ability to Learn Wrestling. The predictive index of a correlation coefficient this large permits accuracy of prediction only 14 per cent better than mere "guess" (*i.e.*, Mean ± 2.58 σ of the wrestling ability scores). Therefore, the individual predictive value of a correlation coefficient of .498 is not large enough to be very useful. Since the correlation coefficient of the Iowa-Brace and the Metheny Revision of the Johnson Test with the Learning of Wrestling Skills were smaller than .498, these two "motor educability" tests would be of less value than the Strength Test in predicting wrestling ability.

Low correlation coefficients were found between the Iowa-Brace and Metheny Revision of Johnson Test (.402 ± .11); Metheny Revision and McCloy Strength Tests (.319 ± .12); and Iowa-Brace and McCloy Strength Tests (.273 ± .13). Evidently the two tests of "motor educability" were not measures of the same ability.

Table 3 shows a multiple R of .602 ± .17 between the criterion, Ability to Learn Wrestling, and a composite score of two "motor educability" tests and a strength test. This R has a Predictive Index of 20 per cent better than "guess" (*i.e.*,Mean ± 2.58 σ of the wrestling ability scores). An example will illustrate its predictive efficiency: a student has a Metheny Revision of the Johnson Test score of 22, an Iowa-Brace score of 37, and a McCloy's General Strength Quotient of 80. The estimated Ability to Learn Wrestling Score and its limits of fluctation are as follows:

$$x_0 = .0624(22) + .2624(37) + .1301(80) - 4.82$$
$$x_0 = 16.72$$
$$\sigma \text{ est} = 3.09 \times 2.58 = 7.97$$
$$x_0 = 16.72 \pm 7.97 \text{ or } 25 \text{ to } 9$$

TABLE 3

Multiple Correlation Between the Criterion, Ability to Learn Wrestling, and a Composite Score of Two "Motor Educability" Tests and a Strength Test

Variables	*M*	σ	*r*	
0 = Ability to Learn Wrestling	15.71	3.87		
1 = Metheny Revision	21.29	4.96	$r_{01} = .498$	$r_{23} = .273$
2 = Iowa-Brace	29.13	4.75	$r_{01} = .332$	$r_{12} = .402$
3 = McCloy Strength	88.82	11.46	$r_{02} = .459$	$r_{13} = .319$

β (Beta) Values

$\beta_3 = I_{11} = .385$

$\beta_2 = (\beta_3)\ (C_3) + I_3 = .385\ (-.173) + .389 = .322$

$\beta_1 = \beta_3\ (C_3) + \beta_2\ (B_2) + I_2 = .385\ (-.319) + .322\ (-.402) + .332 = .080$

Multiple Correlation Coefficient

$R0.123 = \sqrt{\beta_1 r_{01} + \beta_2 r_{02} + \beta_3 r_{03}}$

$R0.123 = .602$

Doolittle Worksheet

	A	B	C	I	X
	1	.402	.319	−.332	1.389
	−1	−.402	−.319	+.332	−1.389
		1.000	.273	−.459	.814
		−.162	−.128	.133	−.157
		.838	.145	−.326	.657
		−1.000	−.173	.389	−.784
			1.000	−.498	.502
			−.102	.106	.004
			−.025	.056	.031
			.873	−.336	.537
			−1.000	.385	−.615

Weights for Regression Equation

$$b01.23 = \beta_1 \frac{\sigma_0}{\sigma_1} = .0624$$

$$b02.13 = \beta_2 \frac{\sigma_0}{\sigma_2} = .2624$$

$$b03.12 = \beta_3 \frac{\sigma_0}{\sigma_3} = .1301$$

Score Form Regression Equation

$K = M_0 - (M_1 b_{01.23} + M_2 b_{02.13} + M_3 b_{03.12})$

$K = -4.82$

$X_0 = b_{01.23} X_1 + b_{02.13} X_2 + b_{03.12} X_3 + K$

$X_0 = .0624 X_1 + .2624 X_2 + .1301 X_3 - 4.82$

Standard Error of Estimate

$\sigma_{12} = \sigma_0 \sqrt{1 - (R0.123)^2}$

$\sigma_{12} = 3.09$

On the 1 per cent level (2.58), the limits of fluctuation in 99 chances out of 100 are too large. Such a large range in individual prediction accuracy makes an R of .602 of little value. The actual wrestling ability scores of the students in this report ranged from 7 to 26. Therefore, administering two "motor educability" tests and a strength test to predict individual ability to learn to wrestle is not very useful and somewhat impractical.

Summary and Conclusions

Scores of 56 freshman and sophomore college students on two "motor educability" tests, a strength test, and a wrestling ability evaluation form after eight-weeks instruction were correlated. These students selected wrestling as the activity which they wished to learn in their required physical education classes. None of these students had ever participated or received instruction in wrestling previously. Two tests of "motor educability" (Iowa-Brace and Metheny Revision of Johnson Test) and a strength test (McCloy's General Strength Quotient) were administered to the students during the first week of the eight week session. During the next six weeks an acceptable program of wrestling instruction was given the subjects. In the final week, three competent judges assessed the wrestling ability of the subjects through the use of tournaments and a scoring card. Both zero-order and multiple correlations were calculated in an effort to evaluate the usefulness of the three tests in determining ability to wrestle.

The following conclusions were drawn, based upon an analysis of the data collected in this study:

1. Although the Iowa-Brace Test and the Metheny Revision of the Johnson Test were both purported to be "motor educability" tests, a fairly low correlation coefficient ($.40 \pm .11$) was found between the two tests. Evidently these two tests of "motor educability" were not measures of the same ability.

2. The McCloy's General Strength Quotient gave the best index ($.498 \pm .10$) of ability to learn an unfamiliar or new activity (in this study, wrestling). The individual predictive value of this Quotient was of little worth.

3. The two "motor educability" tests, Iowa-Brace and Metheny Revision of the Johnson Test, were of less individual predictive value, in ability to learn wrestling, than McCloy's General Strength Quotient.

4. A battery including two tests of motor educability and a strength test was both impractical and of little worth in predicting individual learning ability of college students in wrestling.

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Effects of Aqua Lung on Circulation of Adults While on Dry Land[1]

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Abstract

This study was concerned with the investigation of pulse rate and blood pressure changes following exercise on a bicycle ergometer with and without breathing through an aqua lung. The subjects tested were 28 men and 32 women. The results indicate that the aqua lung causes no changes in the circulation measurements even when no practice is given to the user of the lung. There is no indication of hyperventilation or fatigue caused by breathing compressed air through the equipment. The women reacted more to the exercise than the men and had higher measurements at rest with respect to the pulse rates.

RECENTLY in California there have been several drownings involving persons using standard aqua lung equipment (SCUBA) that was found to be free of mechanical failures. One of these occurred at Santa Barbara College and involved a girl who was using the lung while on the surface of the ocean. When the literature was read concerning the possible effects of the aqua lung on the circulation, no study was found which gave any data on this subject.

Since the equipment used at Santa Barbara was involved in the drowning, a duplicate lung belonging to the school was obtained and used in this study. The tank was filled with compressed air under 2,000 pounds pressure.

Because the tank contained air and not pure oxygen, the only possible causes, other than mechanical, for rebreathing problems would be hyperventilation due to the aqua lung or psychological fear of the equipment.

The purpose of this study was to investigate the possible effects of the aqua lung when used without practice-diving exercise.

Subjects and Testing Procedure

The subjects in this study were members of an advanced physiology class at Santa Barbara in 1954 and 1955. There were 32 women and 28 men tested. The ages of the women ranged from 19 to 27 years and the men from 20 to 28 years. All were healthy, normal students free of disease.

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[1]This study was partially supported by research grant No. 91 from Santa Barbara College.

The subjects were told what the procedure of the testing would be but were not given the chance to practice, since the psychological factor of using the aqua lung was to be investigated.

The subject came into the laboratory, sat upon a stationary bicycle, and the aqua lung was put on. After resting for ten minutes and when the pulse rate and blood pressure measurements had leveled off, the subject pedalled for one minute at the rate of 144 cycles per minute. This amounted to riding for 2/10 of a mile at a speed of 12 miles per hour.

The subject recovered from the exercise and then repeated the exercise. The subjects were alternated so that half rode with the lung being used on the first ride and without using the lung on the second. The other half rode first without the lung being used and secondly with it.

Pulse rate (30 sec. count) and blood pressure measurements were taken before, within five seconds of the end of exercise, and each minute following exercise during five minutes of recovery.

Results

Table 1 shows the difference between the first ride and the second on any testing day. Differences would show either the effects of warm up or fatigue. In this study there are no significant differences, indicating that any dif-

TABLE 1

Mean Differences Between First and Second Rides on Testing Day

Measurement	Before Exercise	End of Exercise	1 min. after	2 min. after	3 min. after	4 min. after	5 min. after
	Men						
Pulse rate (per min.)	−7	1.4	2.7	3.1	2.4	2.4	1.9
Systolic blood pressure (mm Hg)	1.3	−3.5	− .9	−1.6	− .7	.4	.2
Diastolic blood pressure (mm Hg)	1.8	.8	.3	.7	− .6	0	.2
Pulse Pressure (mm Hg)	− .5	−2.7	− .6	− .9	− .1	.4	0
	Women						
Pulse rate (per min.)	− .1	1.1	− .5	2.2	2.3	2.4	1.8
Systolic blood pressure (mm Hg)	.8	− .3	−1.6	−1.4	− .4	−2.0	− .3
Diastolic blood pressure (mm Hg)	− .4	− .6	1.2	1.6	.8	1.5	2.5
Pulse pressure (mm Hg)	1.2	.3	− .4	− .2	− .4	− .5	−2.2

NOTE: Diastolic blood pressures were taken at the fourth phase.

ferences between the tests are not caused by the fatigue of one test following another, or by any warm-up carrying over to the second ride on any testing day.

From Tables 2, 3, 4, and 5 can be seen the mean changes between the exercises when the lung is used and when not used. No significant differences

TABLE 2

Mean Pulse Rates/Minute With and Without Aqua Lung

Pulse Rate	Before Exercise	Immediately after	1 min. after	2 min. after	3 min. after	4 min. after	5 min. after
	Men						
With lung	73.8	91.5	75.0	74.2	75.8	76.2	76.0
Without lung	74.0	94.0	74.8	73.9	74.9	76.3	75.4
Difference	.2	2.5	— .2	— .3	— .9	.1	— .6
	Women						
With lung	82.9	107.2	90.5	86.2	84.5	82.9	83.0
Without lung	82.0	112.2	91.5	85.8	85.9	84.1	85.2
Difference	— .9	5.7	1.0	— .4	1.4	1.2	2.2

TABLE 3

Mean Systolic Blood Pressures (mm Hg) With and Without Aqua Lung

Systolic Blood Pressure	Before Exercise	Immediately after	1 min. after	2 min. after	3 min. after	4 min. after	5 min. after
	Men						
With lung	122.4	135.9	126.0	124.1	126.5	120.9	119.5
Without lung	119.9	135.5	129.1	124.4	122.7	120.6	119.9
Difference	— 2.5	— .4	3.1	.3	— 3.8	— .3	.4
	Women						
With lung	116.8	136.2	128.5	122.5	117.8	116.3	116.9
Without lung	117.1	136.7	129.9	117.9	118.5	119.1	117.9
Difference	.3	.5	— 1.4	— 4.6	.7	2.8	1.0

TABLE 4

Mean Diastolic Blood Pressures (mm Hg) With and Without Aqua Lung

Diastolic Blood Pressure	Before Exercise	Immediately after	1 min. after	2 min. after	3 min. after	4 min. after	5 min. after
	Men						
With lung	86.6	81.0	85.6	84.4	86.7	86.7	86.3
Without lung	84.7	79.8	86.3	87.2	86.7	86.5	86.5
Difference	— 1.9	— 1.2	.7	2.8	0	.2	.2
	Women						
With lung	79.8	76.2	80.8	81.1	80.5	80.8	80.8
Without lung	80.3	78.6	80.3	80.9	81.4	80.9	81.3
Difference	.5	2.4	.5	— .2	.9	.1	.5

TABLE 5

Mean Pulse Pressure Changes (mm Hg) With and Without the Aqua Lung

Pulse Pressure Change	Before Exercise	Immediately after	1 min. after	2 min. after	3 min. after	4 min. after	5 min. after
	Men						
With lung	35.8	54.9	40.4	39.7	39.8	34.2	33.2
Without lung	35.2	55.7	42.8	37.2	36.0	34.1	33.4
Difference	— .6	.8	2.4	— 2.5	— 3.8	— .1	.2
	Women						
With lung	37.0	60.0	57.5	41.4	37.3	36.5	36.1
Without lung	36.8	58.1	49.6	37.0	37.1	38.2	36.6
Difference	— .2	— 1.9	— 7.9	— 4.4	— .2	— 1.7	.5

were found in the pulse rate or the blood pressure measurements with either the men or women. There are as many measurements that increased as decreased when the lung was used.

The only significant differences found in the study were those between the men and women. At all times the women had higher pulse rates, significant at the 5 per cent level, and slightly, but insignificantly, lower systolic and diastolic blood pressure measurements. The pulse pressures were slightly higher for the women immediately after and one minute after the exercise.

The women reacted more to the exercise in that their average pulse rate and systolic blood pressure measurements rose more than the men's. Table 6 shows the average change in the measurements between rest and exercise. Only four of the men had pulse rate increases as high as 30 beats per minute while the women had nine whose pulse rates increased as high as 40 beats per minute. There were only four men whose systolic blood pressures increased 20 mm Hg.

TABLE 6

Mean Change Between Resting and End of Exercise Measurements

Measurement	Unit	Men		Women	
		Mean	σ	Mean	σ
Pulse rate	Beats/min	19.1	6.4	27.3	8.2
Systolic pressure	mm Hg	15.3	5.9	19.2	6.6
Diastolic pressure	mm Hg	— 5.1	2.7	— 3.0	2.1
Pulse pressure	mm Hg	20.8	7.4	22.6	6.6

The diastolic blood pressures decreased with each group following the exercise with the men having the greatest change. None of the subjects felt any ill effects from the testing, and following the use of the equipment there was general agreement in the ease of breathing while using the aqua lung.

The study indicates that the aqua lung itself has no effect on the circulation as might be expected from hyperventilation due to the fear of the equipment or inadequate breathing.

In comparing the women and men, it is of interest to note that the resting diastolic pressures are lower with the women in this study whereas Metheny (5) found the measurement to be higher.

A recent study by Henschel (6) pointed out the systematic errors found when using the indirect method of measuring blood pressures following work. In this study there also was difficulty in determining the diastolic pressure but to offset some of the artifact the fourth phase diastolic pressure was taken. Since one examiner did all of the blood pressure measurements, it was felt that other errors were also reduced.

In Henschel's study (6), the direct measurment of diastolic blood pressure showed decreases in the diastolic blood pressure following exercise. This was similar to the results as seen in Table 4. The diastolic blood pressures of the men decreased an average of 5 mm Hg pressure following exercise and returned to normal after resting one minute following exercise. It is not understood why our findings should compare with Henschel's data when he used a direct blood pressure measurement, and did not agree with his indirect technique. Possibly the fourth phase diastolic pressure we used is better than the complete fade-out, as used by Henschel in his study. When the complete fade-out diastolic pressure was attempted, it was found that many of the subjects had no complete fading of the sound. The fourth phase diastolic pressure appears to be a better measurement of the true diastolic pressure.

It should be pointed out that different results may occur if the aqua lung is used under water. The pressure of the water or fear of the water could have an effect upon the subject. This study was designed to test only the aqua lung itself and not the effects of the water. Further study is necessary to answer questions concerning water pressures and the psychology of diving. Also of note is the fact that with only one minute of exercise there may not have been enough time for the accumulation or blowing off of CO_2 because of hyperventilation or rebreathing difficulties. Three of the men were tested for 15 minutes in a manner similar to this study and in these cases there were no significant differences in the measurements. However, not enough work was done, because of the amount of air needed to continue this phase of investigation, so that no statement can be made concerning longer periods of exercise.

Summary

In this study 32 women and 28 men between 19 and 28 years of age were tested before and for five minutes following a standard bicycle ride. One test was taken while rebreathing with an aqua lung (SCUBA) and the other test while not rebreathing with the lung. During both tests the lung was strapped to the subject's back.

The results indicated by the study are as follows:

1. There were only small insignificant differences between the tests when the lung was used and when not used.
2. The women had significantly higher pulse rate measurements and slightly lower systolic blood pressure measurements throughout the testing.
3. The pulse rate and systolic blood pressure measurements of the women increased more than those of the men as a result of the exercise.
4. Both groups recovered from the exercise within 5-7 minutes following the exercise.
5. There were no ill effects from the use of the aqua lung.

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Electromyographic Study of Selected Muscles Involved in Movements of Upper Arm at Scapulohumeral Joint[1]

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Abstract

This article presents an investigation, by means of electromyography, of the functions of the biceps brachii, the deltoideus, the latissimus dorsi, the pectoralis major, the serratus anterior, the cleido mastoideus, the teres major, the trapezius, and the triceps brachii (long head) in movements of the upper arm and the shoulder girdle at scapulohumeral, acromioclavicular, and sternoclavicular joints. The procedure for collecting the data was established on the basis of records taken on twelve subjects; and the findings that are reported were based on 20 complete sets taken on five subjects.

THE PURPOSE OF of this study was to investigate, by means of electromyography, the functions of the biceps brachii, the deltoideus, the latissimus dorsi, the pectoralis major, the teres major, and the triceps brachii (long head) in movements of the upper arm at the scapulohumeral joint.

Related Studies

Findings from several electromyographic studies that deal with the same muscles and, at least in part, with the same movements as those included in the present study have been reported in the literature.[2]

Inman, Saunders, and Abbott (2) studied, along with other muscles not included in the present investigation, the deltoideus, the pectoralis major, and the teres major. They reported that, in flexion of the upper arm, the del-

[1]This study was submitted in 1955 in partial fulfillment of the requirements for the degree of Doctor of Philosophy in the Division of Physical Education in the Graduate College of the State University of Iowa.

[2]In the following electromyographic studies, findings are reported relative to some of the same muscles but not to the same movements as those investigated in the present study: Robert M. Holmer, *An Electromyographic Study of the Actions of Selected Muscles of the Upper Extremity*, Doctoral dissertation, State University of Iowa, 1954; and Duane R. Slaughter, *An Electromyographic Study of the Superficial Muscles Involved in Prescribed Movements*, Doctoral dissertation, State University of Iowa, 1954.

toideus, the clavicular part of the pectoralis major, and the manubrial segment of the sternocostal part of the pectoralis major registered action potentials; and, in abduction of the upper arm, the deltoideus registered action potentials.

McCloy (3) studied, along with another muscle not included in the present investigation, the deltoideus, the pectoralis major, and the triceps brachii. He reported that, in flexion of the upper arm, the anterior and the middle part of the deltoideus registered action potentials; in forward-lateralward elevation of the upper arm, the anterior and the middle part of the deltoideus and the clavicular part of the pectoralis major registered action potentials; in abduction of the upper arm, the anterior and the middle part of the deltoideus registered action potentials; in lateralward-backward elevation of the upper arm, the middle and the posterior part of the deltoideus registered action potentials; in backward elevation of the upper arm, the middle and the posterior part of the deltoideus registered action potentials; and, in lateralward-backward and in backward-medialward elevation of the upper arm, the long head of the triceps brachii registered action potentials.

Slater-Hammel (4, 5) studied the biceps brachii, the deltoideus, the latissimus dorsi, the pectoralis major, and the triceps brachii. He reported that during some part of the driving phase of the golf stroke, the right biceps brachii, the posterior parts of the deltoidei, the right latissimus dorsi, the right pectoralis major, and the tricipites brachiorum registered action potentials (right-handed performer); and, during some part of the forward movement of the driving arm in the tennis stroke, the biceps brachii, the anterior and the middle part of the deltoideus, the latissimus dorsi, and the pectoralis major registered action potentials.

Bierman and Yamshon studied the biceps brachii (1) and the deltoideus (6). They reported that, in flexion, in extension, and in abduction of the upper arm, the biceps brachii registered action potentials; in adduction and in medialward rotation of the upper arm, the anterior part of the deltoideus registered action potentials; and, in abduction and in lateralward rotation of the upper arm, the posterior part of the deltoideus registered action potentials.

Comparisons of the findings in the studies reported in this section cannot be made with precision because of the lack of information in the indication of the starting and the finishing positions of the movements.

Procedure

A Grass electroencephalograph (Model III-D) equipped with four channels and with four ink-writing recorders was used for recording action potentials (see Figure I). The action potentials were recorded on encephalograph paper that was folded into packages of one thousand sheets, each sheet being one foot in length and four inches in width. Recordings were taken with the paper passing through the ink-writing recorders at a rate of 30 mm. a second.

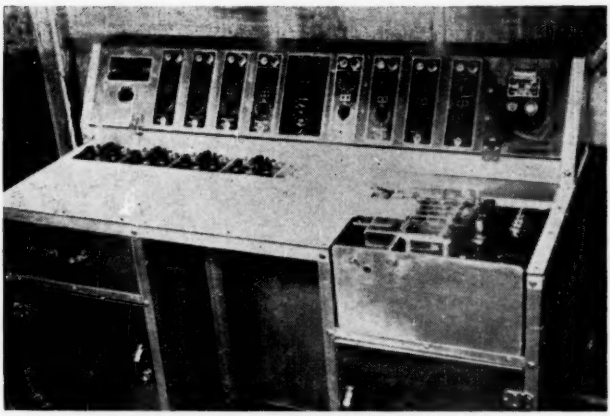

FIGURE I. Grass Electroencephalograph.

For the recording of the action potentials of each muscle, two surface electrodes, each of which was about 8 mm. in diameter, were placed on the integument in the area of the motor point of the muscle and were held in place by flexible collodion. In the testing of the middle and the posterior part of the deltoideus, the latissimus dorsi, and the clavicular part of the pectoralis major, the electrodes were placed 4 cm. apart and, along the length of the fibers of the muscle, equidistant from the motor point. In the testing of the long and the short head of the biceps brachii and the teres major, one electrode was placed upon the motor point; and the other, along the length of the fibers of the muscle, 4 cm. proximal to the motor point.

In the testing of the anterior part of the deltoideus, the sternocostal part of the pectoralis major, and the long head of the triceps brachii, one electrode was placed upon the motor point; and the other, along the length of the fibers of the muscle, 4 cm. distal to the motor point. The motor points of the muscles were located by means of a faradic stimulator. The electrode resistance was kept below 15,000 ohms when the recordings were taken. The amplification of the electroencephalograph was calibrated at the beginning and at the end of each period of recordings for each subject.

Electromyograms were obtained for extension and for flexion of the upper arm in a sagittal plane, for adduction and for abduction of the upper arm in a frontal plane, and for abduction and for adduction of the upper arm in a horizontal plane (see Figures II and III). The starting and finishing positions for these movements are indicated in the section on "Findings." Flexion, extension, frontal adduction, and frontal abduction of the upper arm were performed on a shoulder wheel attached to a wall; and horizontal abduction and horizontal adduction, on a shoulder wheel placed on a table. The subject, grasping a handle attached to the edge of the shoulder wheel, performed

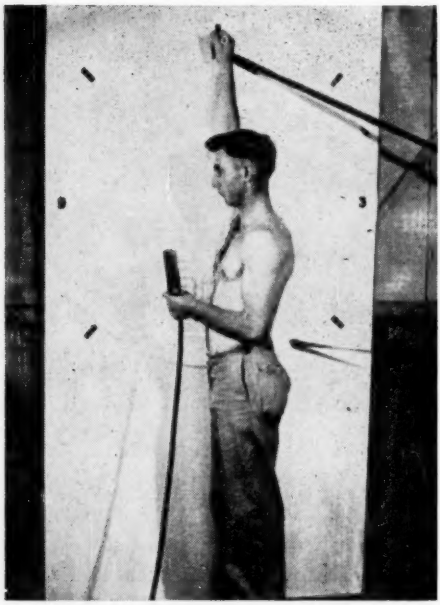

FIGURE II. Shoulder Wheel Attached to Wall.

the movements which exerted pressure toward the shoulder wheel and which exerted pressure away from the shoulder wheel. The experimenter offered resistance to the movements by pulling on the two ends of a rubber band, into the loop of which the handle of the shoulder wheel had been inserted.

For flexion, extension, frontal adduction, and frontal abduction of the upper arm the subject was in a standing position. For horizontal abduction and horizontal adduction of the upper arm, the subject was in a sitting position. All the movements were performed with the forearm extended and supinated, with the forearm extended and semipronated (i.e., in midposition between extreme supination and extreme pronation), and with the forearm extended and pronated.

Twelve male subjects, who were members of the faculty and of graduate classes in the School of Health and Physical Education at the University of Oregon and in the Division of Physical Education at the State University of Iowa, were used in a pilot study.

Five male subjects, who were graduate students in the Division of Physical Education at the State University of Iowa, were used for the present study. Twenty records of each movement, with each movement executed three to six times, were obtained from the five subjects. Two complete sets of records were obtained from two of the subjects.

FIGURE III. Shoulder Wheel Lying on Table.

Findings

In this section are indicated the movements that were performed, and the muscles that were effective in the performance of these movements.

Values of *0* to *4* were assigned to the heights of various parts of the records of the action potentials (see Figure IV). A *0* indicated that no action potentials were registered; *1*, weak action potentials; *2*, medium action potentials; *3*, strong action potentials; and *4*, very strong action potentials. The lower of the values, depending on the pressure exerted, (i.e., toward or away from the wheel) was considered the rating of the action potentials that were effective in the designated part of the designated movement. For example, *3* was assigned to the record of the action potentials of the teres major in the first part of the extension of the upper arm with pressure exerted lateralward, and *1* to the record of the action potentials of the same muscle in the same part of the extension of the upper arm with pressure exerted medialward. Hence, *1* was, for the teres major, the estimated rating of the action potentials that were effective in the first part of the extension of the upper arm.

The muscles, that are listed in the findings that follow, are the ones of which the action potentials received estimated ratings of medium (2), strong (3), or very strong (4). If no parentheses appear after the muscle, action potentials were registered with the forearm supinated, semipronated, and pronated. If parentheses appear after the muscle, action potentials were registered only with the forearm in the position designated within the

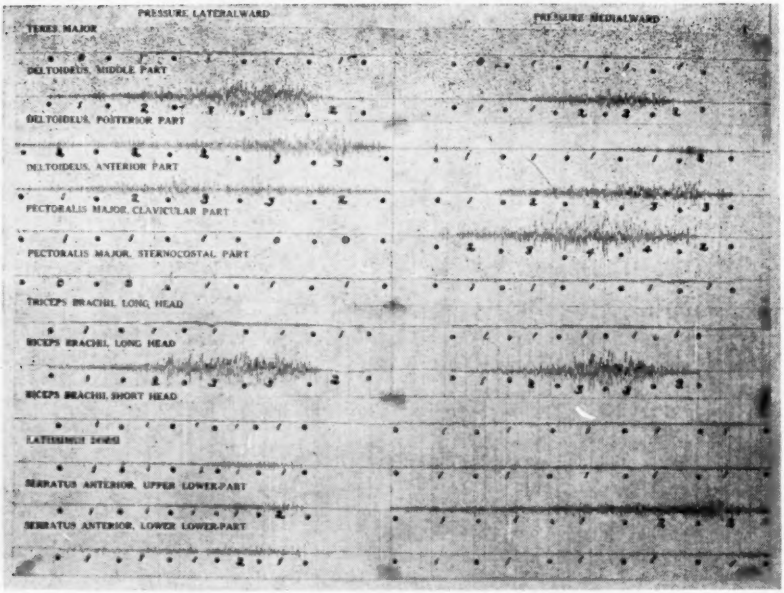

FIGURE IV. A Recording of Action Potentials.

parentheses. No differentiation has been made between the muscles that registered action potentials that were rated of medium or greater strength for an entire phase of a movement and the muscles that registered action potentials of such strength for only a part of the phase of the movement.

UPPER-ARM EXTENSION IN SAGITTAL PLANE

From a starting position in which the inferior end of the upper arm was directed upward, the upper arm was moved forward and downward to the level of the shoulder (first phase), then downward and backward to the side of the body (second phase), and then backward and upward to the terminal position in which the inferior end of the upper arm was directed downward and backward (third phase). *In the first phase* of the movement, the middle part of the deltoideus (forearm supinated), the clavicular part of the pectoralis major, and the latissimus dorsi (forearm pronated), registered action potentials. *In the second phase* of the movement, the posterior part of the deltoideus, the long head of the triceps brachii (forearm semipronated and pronated), and the lattissimus dorsi (forearm semipronated) registered action potentials. *In the third phase* of the movement, the posterior part of the deltoideus, the long head of the triceps brachii (forearm pronated), and the latissimus dorsi (forearm semipronated) registered action potentials.

UPPER-ARM FLEXION IN SAGITTAL PLANE

From a starting position in which the inferior end of the upper arm was directed downward and backward, the upper arm was moved downward and forward to the side of the body (first phase), then forward and upward to the level of the shoulder (second phase), and then upward and backward to the terminal position in which the inferior end of the upper arm was directed upward (third phase). *In the first phase* of the movement, the long head of the biceps brachii (forearm supinated and semipronated) registered action potentials. *In the second phase* of the movement, the middle part of the deltoideus, the anterior part of the deltoideus, and the long head of the biceps brachii, registered action potentials. *In the third phase* of the movement, the middle part of the deltoideus, the posterior part of the deltoideus (forearm pronated), the anterior part of the deltoideus, the long head of the biceps brachii, registered action potentials.

UPPER-ARM ADDUCTION IN FRONTAL PLANE

From a starting position in which the inferior end of the upper arm was directed upward, the upper arm was moved lateralward and downward to the level of the shoulder (first phase), then downward and medialward to the side of the body (second phase), and then, in front of the body, medialward and upward to the terminal position in which the inferior end of the upper arm was directed downward and medialward (third phase). *In the first phase* of the movement, the teres major (forearm semipronated), the posterior part of the deltoideus (forearm supinated and semipronated), the long head of the triceps brachii (forearm pronated and semipronated), and the latissimus dorsi (forearm semipronated), registered action potentials. *In the second phase* of the movement, the teres major (forearm semipronated), the anterior part of the deltoideus (forearm supinated and semipronated), the clavicular part of the pectoralis major (forearm semipronated), the long head of the triceps brachii (forearm supinated and semipronated), the long head of the biceps brachii (forearm pronated), the short head of the biceps brachii (forearm semipronated and pronated), registered action potentials. *In the third phase* of the movement, the middle part of the deltoideus (forearm pronated), the anterior part of the deltoideus (forearm supinated and pronated), the clavicular part of the pectoralis major (forearm supinated and pronated), the long head of the biceps brachii, and the short head of the biceps brachii (forearm semipronated and pronated), registered action potentials.

From a starting position in which the inferior end of the upper arm was, in back of the body, directed lateralward and downward, the upper arm was moved downward and medialward to the back of the body (first phase), and then medialward and upward to the terminal position in which the inferior end of the upper arm was directed downward and medialward in back of the body (second phase). *In the first phase* of the movement, the teres major (forearm supinated and pronated), and the latissimus dorsi (forearm semi-

pronated), registered action potentials. *In the second phase* of the movement, the teres major, the long head of the triceps brachii, the latissimus dorsi (forearm supinated and semipronated), registered action potentials.

UPPER-ARM ABDUCTION IN FRONTAL PLANE

From a starting position in which the inferior end of the upper arm was, in front of the body, directed downward and medialward, the upper arm was moved downward and lateralward to the side of the body (first phase), then lateralward and upward to the level of the shoulder (second phase), and then upward and medialward to the terminal position in which the inferior end of the upper arm was directed upward (third phase). *In the first phase* of the movement, the long head of the triceps brachii (forearm semipronated) registered action potentials. *In the second phase* of the movement, the middle part of the deltoideus, the posterior part of the deltoideus (forearm pronated), the anterior part of the deltoideus (forearm supinated and pronated), the long head of the biceps brachii (forearm supinated) and the latissimus dorsi (forearm supinated and pronated) registered action potentials. *In the third phase* of the movement, the middle part of the deltoideus, the posterior part of the deltoideus (forearm pronated), the anterior part of the deltoideus, the long head of the biceps brachii (forearm supinated and semipronated), the latissimus dorsi (forearm supinated and pronated), registered action potentials.

From a starting position in which the inferior end of the upper arm was, behind the body, directed downward and medialward, the upper arm was moved downward and lateralward to the side of the body (first phase), and then lateralward and upward to the terminal position in which the inferior end of the upper arm was directed downward and lateralward (second phase). *In the first phase* of the movement, the middle part of the deltoideus, registered action potentials. *In the second phase* of the movement, the middle part of the deltoideus, the anterior part of the deltoideus (forearm supinated), the long head of the biceps brachii (forearm supinated and semipronated), registered action potentials.

UPPER-ARM ABDUCTION IN HORIZONTAL PLANE

From a starting position in which the inferior end of the upper arm was, at the level of the shoulder, directed forward and medialward, the upper arm was, at the level of the shoulder, moved forward and lateralward until the inferior end of the upper arm was directed forward, and then, at the level of the shoulder, lateralward and backward until the inferior end of the upper arm was directed lateralward (first phase), and then, at the level of the shoulder, backward and medialward to the terminal position in which the inferior end of the upper arm was directed lateralward and backward (second phase). *In the first phase* of the movement, the middle part of the deltoideus (forearm semipronated and pronated), and the posterior part of the del-

toideus, registered action potentials. *In the second phase* of the movement, the middle part of the deltoideus (forearm pronated) and the posterior part of the deltoideus, registered action potentials.

From a starting position in which the inferior end of the upper arm was, at the level of the shoulder, directed lateralward and backward, the upper arm was, at the level of the shoulder, moved lateralward and forward until the inferior end of the upper arm was directed lateralward (first phase), and then, at the level of the shoulder, forward and medialward until the inferior end of the upper arm was directed forward, and then medialward and backward to the terminal position in which the inferior end of the upper arm was directed forward and medialward (second phase). *In the first phase* of the movement, the clavicular part of the pectoralis major (forearm supinated and semipronated), the long head of the biceps brachii, and the short head of the biceps brachii, registered action potentials. *In the second phase* of the movement, the anterior part of the deltoideus, the clavicular part of the pectoralis major, the long head of the biceps brachii (forearm semipronated and pronated), and the short head of the biceps brachii, registered action potentials.

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Changes in Body Fat, Estimated from Skinfold Measurements of College Basketball and Hockey Players During a Season[1]

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Abstract

Body weights and skinfold measurements were determined in ten varsity, four freshmen basketball players and 12 hockey players before and after a season of play in their respective sport (total, 26 athletes). The men maintained relatively constant body weight but a redistribution of weight was evident from the skinfold findings. The men lost subcutaneous fat in the three skinfold sites measured. Attention is focused on the skinfold method as one deserving of more attention in physical education research. The skinfold procedure is a rapid, reasonably precise, and inexpensive method for estimating body fat.

BODY FAT has long been recognized as one of the major variables associated with changes in body composition. It can be altered by changes in nutrition, disease, and exercise. Several methods have been devised to estimate the fat content of the body, but the most applicable method for routine health and physical education testing is the skinfold method. It is inexpensive, measurements are quickly and easily made, and it affords a reasonable estimate of the total body fat (11, 12, 24, 33).

The objectives of this paper are twofold:

(a) To familiarize physical educators with present techniques for measuring skinfolds and to discuss some of the problems of skinfold measurement.

(b) To present skinfold data obtained on varsity basketball and hockey players before and after a season of participation.

Frequently investigators typify individuals with a label or number synonymous with a constitutional body type (36) when they may actually be interested in fatness. This approach is misleading to the extent that one constitutional body type (i.e., endomorphy) has been identified with a relative

[1]Gratitude is expressed to Matt Zunic, Varsity Basketball Coach, and Harry Cleverly, Varsity Hockey Coach, both of Boston University, for their co-operation in this study.

predominance of soft roundness throughout the body which suggests, in essence, relative fatness, and principally subcutaneous fatness. If one is primarily interested in fatness *per se,* it is reasonable to attempt to assess "fatness" directly rather than from reference to a constitutional body type; the latter implies permanency although body fat is known to be alterable (24).

Background

The literature on skinfold measurement has recently been thoroughly reviewed (10, 11, 14, 21, 24). Pinching a skinfold with the fingers to survey "nutritional status" is an old clinical technique. Richer, in 1890, was the first to make quantitative measurement of skinfold thickness with calipers. From this early beginning, numerous types, sizes, and shapes of calipers have emerged. Until relatively recently, little or no attempt was made to standardize pressure exerted by the caliper jaw faces or to establish the validity or reliability of individual or multiple skinfold measurements (24, 28).

At the present time, at least six caliper types are being used. They include the older Franzen caliper,[2] the figure eight caliper (31), the Vernier Caliper modified at the University of Minnesota (24), the C-shaped scissor caliper designed by Best (3, 5, 23), the newer C-shaped scissor caliper,[3] and the Hapern skinfold caliper (39). Each caliper has certain advantages with the possible exception of the older Franzen caliper. The pressure exerted

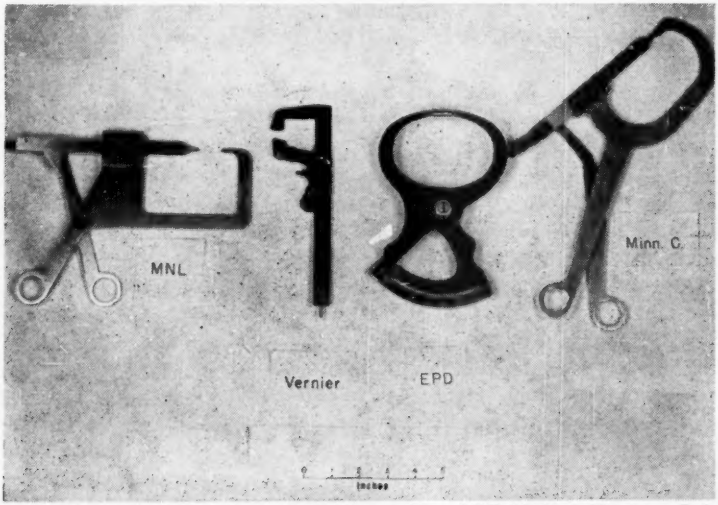

FIGURE 1. Some Skinfold Calipers Currently in Use. MNL-Medical Nutrition Laboratory, Denver, Colo. Vernier-University of Minnesota. EPD-Quartermaster Research and Development Command, Natick, Mass. C.-University of Minnesota.

[2]Available from Stoelting Instrument Company.

[3]Available from Laboratory of Physiological Hygiene, University of Minnesota, Minneapolis, Minnesota.

between the jaw faces of this caliper varies directly with the skinfold thickness. The Minnesota group is currently recommending the C-shaped scissor caliper to facilitate standardization.

When relatively small skinfolds are to be measured (<30 mm) as was the case in this study, the modified Vernier Caliper permits rapid and accurate skinfold measurement at the recommended pressure of 10 gm/mm^2 (23,24,39). It should be pointed out, however, that the caliper chosen for any study should exert a pressure of at least 10 gm/mm^2 between the jaw faces in order to secure reliable results and measurements that may be compared with those of other workers. The measured skinfold thickness is highly dependent on caliper pressure until at least 10 gm/mm^2 is reached (24, 39).

Considerable work has recently been done to establish the validity of extrapolation from skinfold measurements to an estimate of total body fat. It must be remembered that one cannot measure total body fat by skinfolds. Total body fat has only been estimated indirectly in living man from body density, body fluids, and/or the concentration of various fat soluble substances. Direct comparisons between any one of these measures and extractable fat has been made primarily in animals, the data on cadavers being extremely limited. Considerable evidence has accumulated that the body density method yields a reasonable estimate of the total body fat in man (23). Thus, validation of the extrapolation from skinfold measurements to body fat is dependent on the relationship between body density and skinfold thicknesses.

That skinfolds do represent a good estimate of skin plus subcutaneous fat thickness is supported by the work of Baker (2). The coefficient of correlation was 0.952 between the skinfold caliper readings over the arm and thigh, and measurements of skin plus fat thickness from roentgenograms.

Intercorrelations between skinfolds measured at various sites on the body are high (0.7-0.95). Thus, if body fat is to be predicted from multiple skinfolds, one soon reaches a point of diminishing returns. Three or four well selected and properly weighted sites give optimal prediction (12, 34), although subcutaneous fat is known to vary considerably between sites (19, 20, 22, 35).

The sites listed in Table 1 (abdomen, chest, and upper arm) have good predictive value and can readily be measured on the average male. The site on the upper arm has the unique advantage of accessibility and acceptability for both male and female.

Method and Procedure

In this study a Vernier Caliper modified at the Laboratory of Physiological Hygiene, University of Minnesota, was used for measurement of the skinfold thickness. The pressure exerted between the jaw faces was 10 gm/mm^2 of jaw surface. All measurements were made by one investigator who was thoroughly familiar with the technique. The skinfold measurement sites on the body were:

(a) Chest—About 5 cm. from the right nipple on a line toward the uppermost point of the axillary fold (skinfold parallel to this line).
(b). Upper Arm—Over the right triceps, halfway between the olecranon and acromial processes (skinfold parallel to the long axis of the arm).
(c). Abdomen—Approximately 5 cm. to the right of the umbilicus (skinfold oriented laterally).

In making a measurement, the skinfold was lifted with the thumb and index finger and held while the caliper was applied approximately 1-1.5 cm. away. Care was taken to exceed the standard pressure before the measurement was made, in order to reduce the early changes in thickness thought to occur with fluid shifts. Each skinfold was lifted and measured three times. The results reported are the average of the three measurements.

Body weight was measured with a calibrated portable Plima balance graduated in kilograms. The balance was sensitive to plus or minus 20 grams. The subjects were tested initially during the first week of training for their respective sport and again just prior to their last game.

Regression equations formulated by Brozek (7) (from the original work of Brozek and Keys (11)) and Pascale (34) were used to calculate body density (D). These equations are given in Table 1.

The equation of Keys and Brozek (24) was used to compute the proportion of total fat in the body from D.

$$F = \frac{4.201}{D} - 3.813$$

Subjects

A description of the college athletes who participated as test subjects is given in Table 2. The 14 basketball players averaged 21 years of age, 186 centimeters in height and 81 kilograms in weight at the start of the basketball season. The hockey players were the same average age but 10 centimeters shorter and 10 kilograms lighter. The hockey goalie was treated separately because of his relatively different type of conditioning. Unfortunately, the sample size was reduced approximately 40 per cent at the time of the last measurement because of injuries, ineligibilities, and other attritional factors.

Results

Body weight changes are shown in Table 2. The basketball players lost an average of 0.94 kg. while the hockey players lost only 0.42 kg. of body weight. These weight losses were not significant. Some athletes lost while others gained weight. On questioning both groups, it was obvious that many of the athletes stayed reasonably active during the summer months. Some had intensively practiced their respective sport prior to the start of the school season. Thus, a large change in body weight was not to be expected.

Although body weight was not altered significantly during the season, the skinfold measurements clearly indicated that a redistribution of weight

TABLE 1

Equations for Predicting Body Density ($\hat{\gamma}$)[1]

From Combined Skinfolds

Brozek (7), Brozek and Key's Method (10)			Pascale's Method (33)		
Skinfold	a	b,c (mm)	*Skinfold*	a	b,c (mm)
	1.0951			1.08012	
Abdomen		0.00028	$Chest_2$		0.0007123
Chest		0.00073	$Chest_1$		0.0004834
Upper Arm		0.00088	Upper Arm		0.0005513

Formula: $\hat{\gamma} = a\text{-}bx\text{-}cy$

From Single Skinfolds

Brozek (7), Brozek and Key's Method (10)			Pascale's Method (33)		
Skinfold	a	b,c (mm)	*Skinfold*	a	b,c (mm)
Abdomen	1.0990	0.00139	Abdomen	1.085122	0.0010512
Chest	1.0987	0.00158	$Chest_1$	1.084888	0.0012554
Upper Arm	1.1028	0.00230	Upper Arm	1.092317	0.0020240
Back	1.1006	0.00176	Back	1.089565	0.0017865

Formula: $\hat{\gamma} = a\text{-}bx$

Caliper pressure—35 gms/mm^2 of jaw face surface

Body Density—Obtained from Brozek & Keys Sp. Gr. values corrected to 36° C: corrected for mean functional residual air.

Locations

Abdomen—Right of navel

Chest—Above and to right of right nipple

Back—Below right scapula

Arm—On the back, halfway down upper arm.

Caliper pressure—10 gms/mm^2 of jaw face surface

Body Density—determined from underwater weight corrected for functional residual air. (Water temperature—32-36° C.)

Locations

Abdomen—Laterally adjacent to umbilicus on right

$Chest_1$—Juxta nipple, along line between anterior crease of axilla and nipple

$Chest_2$—At the level of the xiphoid in the mid-axillary line

Upper Arm—Mid-posterior mid-point between tip of acromion and tip of olecranon.

Back—At tip of scapula. Lines of linn usually require taking of skinfold in a diagonal plane.

[1]Although descriptions vary slightly, skinfold positions are nearly identical in practice. Chest (Brozek & Keys) and $Chest_2$ (Pascale) are identical for all practical purposes.

TABLE 2

Characteristics and Weight Changes of Varsity Basketball and Hockey Players During a Season of Participation[1]

Team	Subject Number	Age (years)[2]	Height (cm)	Weight Before[3] (Kg)	Weight End[4] (Kg)	Difference B and E
Varsity Basketball						
N = 10	1	22	172.1	78.27	75.50	−2.77
	2	22	203.2	103.87	104.20	0.33
	3	18	193.0	74.35	70.94	−3.41
	4	20	193.0	83.36	80.58	−2.78
	5	23	188.6	79.35	78.57	−0.78
	6	19	188.6	81.53	79.88	−1.65
	7	22	194.3	83.23	83.26	0.03
	8	23	186.7	80.48	81.35	0.87
	9	22	174.6	77.38	75.51	−1.87
	10	21	170.8	61.79	62.81	1.02
Freshmen Basketball						
N = 4	11	24	177.8	88.03	88.55	0.52
	12	18	193.7	89.63	86.28	−3.35
	13	18	176.5	75.05	75.81	0.76
	14	18	191.1	79.44	79.37	−0.07
N = 14						
M		21	186.0	81.13	80.19	−0.94[5]
σ		±2.16	±9.90	±9.33	±9.40	±1.65
Hockey						
N = 11	15	22	176.5	71.04	69.56	−1.48
	16	20	172.7	62.40	62.09	−0.31
	17	22	170.2	76.27	77.21	0.94
	18	19	185.4	69.30	68.39	−0.91
	19	20	171.4	63.50	63.88	0.38
	20	25	181.6	83.95	82.72	−1.23
	21	23	178.4	74.56	75.37	0.81
	22	20	176.5	77.71	77.27	−0.44
	23	22	176.5	74.40	73.78	−0.62
	24	20	182.9	70.00	69.47	−0.53
	25	23	170.2	64.85	63.57	−1.28
M		21	176.6	71.63	71.22	−0.42[5]
σ		±1.81	±5.19	±6.57	±6.56	±.826
Goalie	26	19	165.7	77.79	78.41	0.62

[1]Sign Test (18).
[2]*Age*—to nearest birthday.
[3]*Weight*$_B$—weight before season.
[4]*Weight*$_E$—weight at end of season.
[5]Non-Significant difference.

had occurred (Table 3). Presumably subcutaneous fat had been utilized and muscle mass increased. The greatest changes occurred in the abdominal skinfolds and upper arm, although all three skinfolds were consistently smaller at the end of the season.

TABLE 3

Skinfold Changes at Three Locations in Varsity Basketball and Hockey Players During a Season of Participation[1]

Team	Subject Number	Chest (mm)			Abdomen (mm)			Upper Arm (mm)		
		B[2]	E[3]	Diff	B[2]	E[3]	Diff	B[2]	E[3]	Diff
Varsity Basketball										
N = 10	1	9	9	0	10	7	3	12	12	0
	2	7	6	1	15	10	5	23	18	5
	3	7	6	1	7	5	2	8	7	1
	4	6	5	1	10	7	3	14	7	7
	5	5	5	0	8	5	3	8	7	1
	6	5	4	1	7	5	2	7	6	1
	7	7	5	2	10	7	3	9	6	3
	8	6	6	0	8	6	2	8	8	0
	9	5	4	1	10	6	4	7	5	2
	10	5	5	0	7	6	1	6	6	0
Freshmen Basketball										
N = 4	11	17	15	2	18	11	7	36	32	4
	12	9	6	3	11	7	4	21	9	12
	13	6	5	1	8	7	1	11	9	2
	14	5	4	1	7	7	0	11	7	4
N = 14										
M		7.0	6.0	1.00[4]	10.0	7.0	2.86[5]	13.0	10.3	3.00[6]
σ		±3.17	±2.87	± .88	±3.24	±1.75	±1.79	±8.39	±7.16	±3.33
Hockey		8	6	2	9	6	3	8	4	4
N = 11	15	9	6	3	10	7	3	9	12	3
	16	8	7	1	8	6	2	19	16	3
	17	4	4	0	6	5	1	10	6	4
	18	5	4	1	6	6	0	8	6	2
	19	10	5	5	6	5	1	15	9	6
	20	8	6	2	9	5	4	13	8	5
	21	7	4	3	7	4	3	12	10	2
	22	6	5	1	7	6	1	10	7	3
	23	6	5	1	7	6	1	8	8	0
	24	7	5	2	9	7	2	10	8	2
M	25	7.0	5.0	1.91[4]	8.0	6.0	1.91[5]	11.0	9.0	2.55[6]
σ		±1.76	±.98	±1.38	±1.43	±.90	±1.22	±3.45	±3.27	±2.46
Goalie	26	14	12	2	23	22	1	28	28	0

[1]Sign Test (18).
[2]B—Before season measurement.
[3]E—End of season measurement.
[4]Significant difference: P .01.
[5]Significant difference: P. 01.
[6]Significant difference: P = .05.

Calculations of body density and body fat were made from the skinfolds and the results are shown in Table 4. The regression equations of Pascale (34) yield a lesser body density than those of Brozek (7); hence, the percentage fat was higher using the Pascale equations. The range in change of

TABLE 4

Mean Changes in Body Density and Body Fat as Estimated from Skinfolds

Method	Sport	$Density_B$	$Density_E$	$Diff_{B-E}$	Percent Fat_B	Percent Fat_E	Fat $Kg_{\cdot B}$	Fat $Kg_{\cdot E}$	Fat-Diff (B-E)
Brozek	Basketball	1.07584	1.08001	0.00417	9.19	7.68	7.46	6.16	1.30
Combined	Hockey	1.07803	1.08219	0.00417	8.39	6.89	6.01	4.91	1.10
Brozek Single	Basketball	1.08663	1.08821	0.00158	5.31	4.75	4.31	3.81	0.50
(Chest)	Hockey	1.08660	1.08961	0.00302	5.32	4.25	3.81	3.03	0.78
Pascale Single	Basketball	1.07601	1.07727	0.00126	9.12	8.67	7.40	6.95	0.45
($Chest_1$)	Hockey	1.07599	1.07838	0.00240	9.13	8.27	6.54	5.89	0.65
Brozek Single	Basketball	1.07306	1.07996	0.00690	10.20	7.70	8.28	6.17	2.11
(Upper Arm)	Hockey	1.07729	1.08315	0.00585	8.65	6.55	6.20	4.66	1.54
Pascale Single	Basketball	1.06615	1.07222	0.00607	12.73	10.50	10.33	8.42	1.91
(Upper Arm)	Hockey	1.06987	1.07502	0.00515	11.36	9.48	8.14	6.75	1.39

NOTE: See Table 1 for regression equations and references.

average body fat in kilograms, using all equations, was 0.45-2.11 kg. for both groups of athletes. When the average change in body fat was compared, using both equations from both sources, the changes are quite comparable for the upper arm and chest, as would be expected.

Discussion

At least four groups are currently working with skinfold and other body composition techniques in the United States in an effort to further present-day knowledge in this field. These groups include: Laboratory of Physiological Hygiene, University of Minnesota, Minneapolis; Environmental Protection Division, Quartermaster Research and Development Command Laboratory, Natick, Massachusetts; Medical Nutrition Laboratory; Fitzsimmons Army Hospital, Denver, Colorado; and Fels Research Institute, Antioch College, Yellow Springs, Ohio. More precise parameters for compartments of body composition will no doubt be established by these groups, and others, in the near future.

Body composition measurements in athletes have been attempted infrequently (13, 17, 26, 40); consequently, little is known concerning differences between groups of athletes or differences between athletes and other groups from a college population. One of the first studies of body composition involving athletes was conducted by Welham and Behnke (40), who found that professional football players had a larger "lean body mass" than average Navy men although the mean specific gravity values were not significantly different. A recent study of college athletes and other students showed that wrestlers and cross country runners have higher body densities and less fat than "average" college students (13).

At least two physical educators have been interested in subcutaneous fat (16, 28). Cureton made extensive measurements of skinfolds in college students with the Franzen Caliper and established a Fat Index, which is the sum of the skinfolds at six sites: over the cheek, abdomen, hip, gluteal, front thigh, and rear thigh. He established a Multiple Rating Scale and classified individuals on a 7-point scale of fatness (15, 16). He also made a comparison of the 1936 and 1948 United States Olympic Swimming teams and concluded that the 1948 team had about 2 mm. less subcutaneous fat per measurement than the 1936 team (17). This work was extended to include the relationship of fatness to performance of strenuous physical exercise. Large fat measurements were found to be negatively correlated with performance (26). McCloy (28) and the group at the Iowa Child Welfare Station (6, 29, 30) used five skinfold measurements to determine fatness in children. The Franzen Caliper was used in all of the Iowa studies to establish norms for "average" and "minimum" amounts of fat for males and females 4 to 18 and up.

Little is known about the changes in body composition associated with conditioning and training, except for certain external anthropometric measurement changes. In a study of one dog, Kohlrausch (27) found that, when the dog was trained for several months to perform heavy pulling work on a motor-

driven treadmill, the total body weight decreased from 10.8 to 9.06 kg., specific gravity measured by an air manometric method increased from 1.054 to 1.074, and the estimated fat content decreased from 1.2 to 0.6 kg.. However, a second dog, trained in running for six weeks, showed an increase in total body weight from 9.85 to 10.80 kg., the respective specific gravities were 1.058 and 1.054, and the estimated body fat increased from 10.4 per cent. This dichotomy may be explained on the basis of the difference in the work load of the muscles when running or pulling.

Tanner (38) studied the development of ten "mesomorphic" young men who were under the guidance of a professional weight lifter for four months. The results of this study demonstrated a significant increase of approximately 2 cm. in upper arm circumference, with essentially no change in the skinfold measurements over the front and back of the upper arm. Similar changes were not found in the leg.

A comparison between groups of "active" and "inactive" middle-aged men was made by Brozek (8, 9). The two groups had long-standing differences in habitual physical activity. The "active" men were less fat and more muscular, as estimated from differences in skinfold measurements. The large fat-free weight of the "active" group indicated a minimal loss of muscular tissues. This finding is in contrast to the usual aging trend.

A recent study performed on paratroopers is one of the most extensive to date (33). Body composition was studied before and after paratroop training. The average loss in body weight was only 0.[illegible] kg. and a small but significant increase occurred in body density, as measured by underwater weighing. Radiosulfate available fluid did not change and D_2O available fluid increased 1.55 liters. "Cell mass," calculated from the hydrometric measures, showed a significant increase and body fat decreased significantly. The largest skinfold change appeared in the abdominal skinfold, which is corroborated from the results obtained on the basketball and hockey players.

When a comparison was made with the normative table of Brozek and Keys (12), it was found that the athletes in this study had comparatively "thin" skinfolds. The 20th, 40th, 60th, and 80th percentiles for the abdominal skin folds in 133 male college students were respectively 11.1, 14.5, 19.1, and 24.8mm. A frequency distribution of averaged skinfolds from before and after the season for both hockey and basketball players is given as Table 5. Twenty-five—(96%) of the subjects on this study fell within the 40th percentile for male college students. A similar conclusion was drawn from the arm and chest skinfolds. Other frequency distributions and tables and/or figures of skinfold thickness are available for comparative purposes for both men and women (1, 4, 25, 37).

It can be concluded from these studies and the present one that body fatness, particularly subcutaneous fatness, can be altered by strenuous training. Concomitant with this change in fatness, body density usually increases even if no loss in weight occurs. Since body cells and body water are more

TABLE 5

Frequency Distribution of Skinfold Measurement of Varsity Basketball arnd Hockey Players During a Season of Participation

Interval	Chest			Adbomen			Upper Arm		
	F	ΣF	ΣF%	F	ΣF	ΣF%	F	ΣF	ΣF%
2-3	0			0			0		
3-4	5	5	19.2	0			0		
5-6	12	17	65.4	10	10	38.5	4	4	15.4
7-8	7	24	92.4	12	22	84.7	8	12	46.2
9-10	0			1	23	88.5	6	18	69.3
11-12	0			1	24	92.4	3	21	80.8
13-14	1	25	96.2	1	25	96.2	0		
15-16	1	26	100.0	0			1	22	84.7
17-18	0			0			1	23	88.5
19-20	0			0			1	24	92.4
21-22	0			1	26	100.0	0		
23-24	0			0			0		
25-26	0			0			0		
27-28	0			0			1	25	96.2
29-30	0			0			0		
31-32	0			0			0		
33-34	0			0			1	26	100.0

NOTE: The skinfold measurements made before and at end of season of play were averaged.

dense than body fat, body density could increase without an increase in muscle *per se*. Presumably muscle mass, in certain regions at least, can be increased by training, which lends credence to the usual interpretation of alterations of large muscle groups associated with strenuous training.

The technique of determining body fat and body fat changes from skinfold measurements has many practical applications in the fields of health and physical education. A few are briefly discussed.

(a) Changes in body fat determined from skinfold measurements could be further studied in relation to participation in the various interscholastic and intercollegiate sports (basketball, football, hockey, track, etc.).

(b) Physical fitness tests are frequently used by physical educators to measure the effectiveness of their program. Excesive body fat is a definite handicap in these tests, and allowance for excess fat could be considered in the construction of norms when strength, *per se*, is assessed. The total work done is the important factor.

(c) New norms for total body fat for all age levels need to be established using the recommended techniques for skinfold measurement and the established regression equations for predicting body fat from skinfolds.

(d) Physical educators, school physicians, school nurses, and health educators are frequently called upon to help a child solve an overweight problem. Skinfold measurements could be quickly made and interpreted to the child. A change in "pinch" thickness would be meaningful to him.

(e) For those individuals interested in adult physical fitness and conditioning, a more accurate estimation of body fat change is available than of weight loss.

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New Health Education Implications in the Association of Smoking, Lung Cancer, and Heart Disease

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Abstract

This is a survey of a number of medical research studies on the association of smoking, particularly cigarette smoking, with lung cancer and heart disease. Other data are presented on sex differences, occupational hazards, urban and rural distribution, and death rates of smokers and non-smokers. Recent opinions and reactions of medical cancer research specialists and physicians which have health implications for the health and hygiene teacher and college students are included.

MEDICAL AND HEALTH implications of the association of cigarette smoking and certain disease conditions have been largely kept from the public for the last 20 years. But, since 1950, the public has been becoming increasingly aware of the possible implications. Many popular and scientific books and magazines have published numerous articles on this subject.

The public has become so aroused by the controversy that for the first time in years cigarette sales have declined. According to the United States Department of Agriculture statistics, the sales of cigarettes declined approximately 6 per cent for 1953 and 1954. Sales for 1955 appear to be up slightly, but will not reach the 1953 record level.

Since 1952, the evidence that smoking has some relationship to certain disease conditions has rapidly accumulated, and many medical researchers and physicians have become convinced. But the health educator's problem of keeping abreast with the most recent research and current findings has been complicated by the magnitude of research and publications in the area.

In this study, the authors have surveyed the majority of the literature, largely in scientific, medical, and health magazines, and attempted to summarize impartially the more recent findings and conclusions which have some implications for the teacher of health education and hygiene. The health education and hygiene teacher has a responsibility to teach the facts in this area, even though they may be controversial, based on the most recent and scientific opinions, regardless of his personal bias.

Lung Cancer

For years, the controversy has persisted as to whether the increase in lung cancer has been due to better methods of diagnosis, natural increase in cancer

associated with the aging population, or whether there was a real increase above and beyond the better diagnosis and age factor. A tremendous increase in lung cancer has occurred during the 20th century. In one ten-year period alone, the death rate from lung cancer has jumped 144 per cent. The continued increase in lung cancer, especially in males, constitutes the real over-all cancer increase. Present trends indicate that lung cancer in males will, within the foreseeable future, become the most frequent site of cancer. Sex differences are obviously very important in lung cancer, as it has increased only slightly in the female population.

Currently there appears to be general agreement that at least part of the observed increase in the incidence of lung cancer is real (2). Incidence data collected only recently has served as a helpful clue in the evaluation of environmental factors suspected of influencing cancer development. Several points are of special interest concerning the incidence of lung cancer.

1. Age-specified death rate for lung cancer has been increasing rapidly and nearly universally throughout the western world during the past three decades. A noticeable exception was the countries of Iceland and Norway (11), both of which have a very low rate of tobacco consumption.

2. The increase has occurred predominantly in the male, although an increase is also observed in females.

3. Lung cancer occurs more commonly in urban than rural areas.

4. Lung cancer incidence reaches a peak toward the end of the sixth and beginning of the seventh decade of life and then declines (19).

Thus, if any environmental factors are found to be associated with lung cancer and are regarded to be causative, they must, at least in part, account for the observed incidence pattern of the condition. No attempt will be made in this paper to evaluate the compatibility of the various exogenous factors considered to play a role in the development of lung cancer. Multiple causative factors are generally recognized as being involved, singly or in combination, in producing lung cancer.

TYPES OF LUNG CANCER

Several types of cancer occur in the lungs, probably with different fundamental causes. Epidermoid cancer is a type of cancer that occurs as a cyst in the epidermal layer of cells. Epidermoid cancer of the tongue, oral cavity, lung and larynx appears to be related to some form of extrinsic irritation. Intrinsic factors are undoubtedly important in many cancers but it is thought that the role of extrinsic factors is more important in lung cancer. The majority of lung cancers have been identified as the epidermoid type; approximately 50 per cent, 31 per cent undifferentiated and 19 per cent adenocarcinomas were found in one study (29).

Adenocarcinoma cancers are thought to originate in and from glandular sources and are not caused by extrinsic factors. This type of cancer is also found in the lungs and can only be determined after a careful histological examination and not by the signs and symptoms of the disease.

Data continue to suggest that adenocarcinoma of the lung is less closely associated with smoking than the epidermoid type. Breslow in his study (3) gave some support to the hypothesis that cigarette smoking affects the development of epithelial carcinoma of the lung more than adenocarcinoma of the lung. Six individuals of 46 cases (13%) of adenocarcinoma did not smoke cigarettes; and 28 of 472 patients (6%) with other types of carcinoma (cancer) did not smoke cigarettes. In female lung cancer patients, no association between smoking and the development of adenocarcinoma could be found. Data by Doll and Hill also suggest similar findings (9).

CLINICAL AND STATISTICAL STUDIES

Prior to statistical studies on exogenous factors in lung cancer, several clinicians had expressed their views. As early as 1912, Adler suggested tobacco as a possible factor in the development of lung cancer (1). In the United States Ochsner (28), a cancer specialist, had long felt that lung cancer increases and cigarette consumption had some relationship.

The first significant, though small, study was published by Lombard (23) in 1928 and demonstrated a positive association between smoking and lung cancer. No study involving a large number of cases was published until 1950, but since that time 15 studies in widely separated parts of the world have been made.

In the study of Wynder, Graham, and Croninger (46), published in 1953, all of the suspected exogenous factors were studied. It was thought that only in this manner could one determine whether a given variable was of primary, secondary, or no significance. Control patients of the same age and economic distribution as the lung cancer patients were selected. In view of the obvious sex difference in the incidence, the male and female data were analyzed separately. Finally, because of suspected differences in etiology of the epidermoid lung cancer and the adenocarcinomas (originating in glandular or ductal epithelium), a separation of these histologic types was undertaken. Though the data suggest a few occupations with higher than expected frequency of lung cancer, the majority of the patients with lung cancer had industrial exposures which were similar to those of the controls. A few occupations were found to have an apparently higher frequency of lung cancer, such as painters, woodworkers, metal and gasoline workers, but involved too few people to account for the universal increase in lung cancer. Similar conclusions were drawn by Doll and Hill and Kennaway (9, 18).

Previous lung diseases were no more common among the lung cancer patients except for the chronic cough (bronchitis) which may be due to the greater use of some extrinsic agent among the lung cancer patients as compared to the control patients. Doll and Hill also concluded that previous lung diseases are of no etiologic significance in the development of lung cancer (9).

On the other hand, the data showed a strong association between smoking and lung cancer. Smokers who smoked 20 or more cigarettes a day had ap-

proximately three times greater lung cancer incidence than control patients (44).

During the same period, Doll and Hill independently carried out a similar study in England (9) which was extended to cover 1,465 lung cancer patients and it showed similar results. This study reveals that the risk of development of lung cancer is in accordance with the amount of cigarettes smoked.

Levin (21) calculated the percentage of lung cancer attributable to smoking and found it, in some studies, to be as low as 56 per cent, and in other studies by Doll and Hill and Wynder and Graham as high as 90 per cent. However, even the lowest percentage indicates considerable risk.

From the factors studied by Doll and Hill (8), it appears that among the population of Greater London over the age of 45, those who smoked 25 or more cigarettes a day had an approximately 50 times greater chance of developing cancer of the lung than non-smokers of a similar age.

Again, the evidence in all the studies indicates that the risk of lung cancer increases considerably with the amount of cigarette smoking but also indicates that smoking is not the only factor in lung cancer as a number of non-smokers also have lung cancer. Non-smokers having lung cancer ranged from 1.3 to 14.6 per cent in different studies (17).

Breslow and his group (2) after a four-year study indicated a connection between heavy cigarette smoking and lung cancer. They found 484 individuals (93%) of the lung cancer cases gave histories of having smoked cigarettes and 394 individuals (76%) of the controls gave a similar history. No greater frequency of tobacco usage in other forms (pipe, cigar, chewing, and snuff) occurs among the lung cancer patients when compared with the control group. In fact, 68 patients of the control group used tobacco in a form other than cigarettes exclusively, to only 15 of the lung cancer patients.

Finally, 74 per cent of all lung cancer patients smoked one or more packs of cigarettes on the average per day over the preceding 20 years, compared with the frequency of only 42 per cent among the controls. Excessive cigarette smoking (two or more packs per day) occurred almost four times as frequently among the cancer cases as the control group.

Another study (39) was published in 1954 which attempted to find the relationship, if any, between smoking and the incidence of cancer of the lung. In studying 265 male patients with histologically proven cancer of the lung it was found that 260 were smokers and 5 were non-smokers. Seventy-three per cent of the male patients who smoked were heavy smokers, while 24 per cent were moderate, and 3 per cent were minimal. This study adds weight to the hypothesis that cigarette smoking (when quantity and chronicity are considered) probably represents an additional carcinogenic factor in the inception of primary squamous and epidermoid lung carcinoma.

The British Medical Research Council study, conducted by Dr. Richard Doll, a physician, and Professor A. Bradford Hill of the London School of Hygiene and Tropical Medicine, followed 40,000 English physicians (10) for

two and a half years after recording their smoking habits. The certified causes of deaths presently available are small, but the resulting rates reveal a significant and steadily rising mortality from deaths due to cancer of the lung as the amount of tobacco smoked increases. All 35 deaths from lung cancer among the 40,000 physicians occurred among smokers (mainly cigarette smokers, but also some pipe smokers). Further, a direct relationship was found between the lung cancer death rate and the number of cigarettes smoked daily. Cigarette smoking was also associated with an excess of deaths from coronary artery diseases.

One of the most sensational reports of the dangers in cigarette smoking came in June 1953 with the announcement of findings in the American Cancer Society's large statistical study (15).

In this study, which was directed by statisticians E. Cuyler Hammond and Daniel Horn, volunteers interviewed approximately 200,000 white men between the ages of 50 and 69 in the winter of 1951-1952. This follow-up or prospective type of study makes it possible to find, through interview, the smoking histories of individuals and to follow them, for years if necessary, and at death to determine the association, if any, between the cause of death and histories of smoking.

All previous tobacco-lung cancer studies had been of the retrospective-type or historical-type study in which individuals with lung cancer have been interviewed and their tobacco histories and living habits studied. The retrospective studies have been severely criticized, but we shall see that the results are substantially the same in both types of studies.

By October 31, 1953, there had been 4,854 deaths among the 187,766 older men on which it was possible to secure follow-up reports. Cigarette smokers had a substantially higher death rate not only from lung cancer but also from other forms of cancer and from disease of the coronary arteries. Moreover, they had a higher over-all death rate.

A total of 3,002 deaths occurred among men with a history of regular cigarette smoking. If they had died at the same rate as men who never smoked, only 1,980 would have died. Coronary artery disease claimed 1,386 cigarette users, an excess in some age groups of 100 per cent over non-smokers. Excess mortality up to 100 per cent from other cancers was also recorded for cigarette smokers (mainly in the older age groups). One hundred forty-three of the regular cigarette smokers died of lung cancer, more than three-times the rate among non-smokers (15).

Hammond and Horn are of the opinion that the associations found between regular cigarette smoking and death rates from diseases of the coronary arteries and between regular cigarette smoking and death rates from lung cancer reflect cause and effect relationships, but more information is needed before the same assertion can be made about other specific sites of cancer.

Men with a history of regular cigarette smoking had a much higher death rate than men who had never smoked cigarettes regularly. The death rate in

the cigarette-only category was 65 per cent higher than in the never-smoked category in age group 50 to 54; 60 per cent higher in age group 55 to 59; 102 per cent higher than in age group 60 to 64; and 30 per cent higher in age group 65 to 69. In each age group, the difference was statistically significant, $P = 0.001$ or less (15).

The death rates among men with a history of having smoked cigarettes regularly or some other type of tobacco regularly were higher than in the never-smoked category, with the death rates the highest in cigarette smokers. The difference in death rates between the cigarette and other category and the never-smoked category was statistically significant in all except the oldest age group.

In all four age groups (ages 50-54; 55-59; 60-64; 65-69), the death rates of men who had smoked only cigars regularly were slightly higher than for men who never smoked. The difference is statistically significant in only one age group. The death rates for men who had smoked only pipes regularly were not appreciably different than for men who had never smoked.

Lung cancer deaths in the American Cancer Society's study were few in number and frequently without histological evidence, but from the incomplete results Hammond and Horn (15) made the estimate (at 5% level of confidence) that lung cancer deaths are from three to nine times as common among men with a history of cigarette smoking and five to 16 times as great among cigarette smokers who smoke one pack or more a day than among men who never smoked regularly.

When all cancer sites are considered, the evidence points to the fact that regular cigarette smokers have higher death rates than those who never smoked. However, this tentative conclusion needs further study and additional evidence which is now being collected.

OCCUPATIONAL AND PERSONAL FACTORS

Breslow and his group (2) in a four-year study found an association between heavy cigarette smoking and lung cancer. In addition, they listed several occupations that seemed to have some etiological relationship to the disease. Their data suggested several occupations, in addition to those previously identified, as having a possible etiological relationship in the development of lung cancer. Welders; steam fitters; boilermakers; asbestos workers; occupations associated with the extraction of lead, zinc, copper ore; cooks (commercial); and construction and maintenance janitors, among others, are mentioned.

The number of individuals in this study was small and the most striking difference from the normal population is the exposure to metallic particles, fumes, and products of metallic combustion—the "hot metal" occupations. But these occupations need to be studied intensively before any final conclusions can be drawn.

McConnell and his associates (24) investigated the environmental, occupational, and smoking history of 100 patients with carcinoma of the lung living

in the Liverpool area. Two hundred in-patients of the same age and sex, suffering from diseases other than cancer, were also interviewed. Careful questioning showed that 47 per cent of the cancer patients had been exposed appreciably to various dusts, fumes, and smokes, while 43 per cent of the controls had been similarly exposed, and in approximately the same proportions. Environmental and occupational factors are undoubtedly associated with lung cancer, but the exposure and degree of association is extremely difficult to determine.

ESTIMATED PREVALENCE RATES OF CANCER

In a study from the National Cancer Institute published in 1953 by Sadowsky, Gilliam, and Cornfield (31), similar case history patterns were followed where retrospective histories of smoking were obtained from patients with the illness under review and then compared with similar histories of other persons not having the disease. This study differed slightly from those previously recorded in that the smoking habits of patients with cancer at several additional sites are presented.

In addition, their findings were compared with those of several other previous investigations. With the data at hand, it was possible to compare in more detail the study by Sadowsky and her associates with those of Wynder and Graham and Doll and Hill. Prevalence rates of cancer of the lung per 100,000 white-males were estimated for smokers and non-smokers from the data recorded in these studies to indicate what risk, if any, was involved in smoking. These rates, calculated by the Cornfield method (5) and standardized for all smokers, found prevalence rates of lung cancer of 41.4 per 100,000 males in the Doll and Hill study (10) and 44.7 in the present study. Non-smokers had rates of 3.0 (10) and 9.8 in the present study.

These studies found the estimated lung cancer rate significantly greater in smokers than in non-smokers. A general tendency was manifest in all studies toward an increase in cancer incidence with increased quantities smoked daily.

Type of Tobacco. Recent interpretations of available data have underplayed the role of cigars and pipes in the development of lung cancer as compared to that of cigarettes. It is indeed true that the cigarette smoker appears to have a greater chance to develop lung cancer than the cigar or pipe smoker; yet the chance of the cigar and pipe smoker is also significantly greater than that of a non-smoker. The estimated annual mortality per 100,000 (43) was 40 per cent for pipe smokers and 24 per cent for cigar smokers, as compared with 10 per cent for non-smokers. These data show the importance of studying all types of smoking in an analysis of the effects of smoking on lung cancer.

SEX RATIO

A remarkable change has occurred in the lung cancer sex ratio over the past few decades. In 1912, Adler's report (1) gave a ratio of three males to one female. More recently, lung cancer data has given the sex ratio as high as

24 to one (22). A survey by Moersch and MacDonald (26) gave a ratio of 24 to one for epidermoid lung cancer and only three to one for adenocarcinoma of the lung. The increasing male sex ratio strongly suggests the responsible factor to be an agent to which males have been exposed more and over a longer period of time than women. Wynder and Graham (44) believe the sex difference is compatible with the long-term smoking habits of the two sexes and believe that female lung cancer will continue to rise as the younger female generation with its extensive smoking habits reaches the cancer age.

URBAN AND RURAL DISTRIBUTION

Lung cancer occurs more commonly in urban than in rural areas. In the United States, the lung cancer incidence among males was approximately twice as great in the cities as in the rural areas in 1945.

A similar trend was found in England and Denmark. The cancer incidence in Copenhagen is twice that of the rural areas. Curwen (6) in his study found that the mortality ratio for cancer of the lung in both sexes, and of the larynx in males, increases with increasing urbanization.

Three studies (8, 9, 43) have attributed the higher lung cancer incidence rates in urban areas to the greater cigarette consumption among city dwellers. Mills and Porter (18) in a study of tobacco-smoking habits of an American city found cigarette smoking to be more common in poorer sections of the city than in the cleaner suburban areas, while the reverse was true of cigar and pipe smoking. Cigarette smoking was more predominant in young adults than in older people while people of advanced age commonly smoked cigars or pipes.

A positive association between smoking and lung cancer has now been shown in 15 recent, separate studies (2, 8, 9, 15, 21, 24, 25, 32, 39, 41 (*p. 102*), 44, 47) obtained from more than 6,000 lung cancer patients. Some skepticism has been expressed of all the studies because they differ in the degree of association found. It must be realized that they differ basically in the kind of interviews used. Some of them, for instance, were based on more or less routine hospital records, while others were made in specially designed interviews. The studies also differed as to smoking classifications and the types of tobacco used. Finally, they differed in type of lung cancer cases, with only a few studies insisting on histological proof. In view of these differences, it is surprising that all studies showed a definite association between smoking and lung cancer. The studies by Doll and Hill (English) and Wynder and Graham showed especially close agreement.

Tobacco—A Cause of Lung Cancer

Frequently the criticism is voiced that the increase in lung cancer could be associated with the increase in the number of automobiles, etc., thus implying that there is no real association between lung cancer and cigarette smoking but that it is just a coincidence.

For years researchers have been attempting to prove experimentally, through animal studies, that tobacco tars or some undiscovered product of tobacco will cause cancer. The literature is full of conflicting studies which will not be reviewed here. Most of the studies were not able to produce cancer experimentally.

Wynder, Graham, and Croninger (46), all eminent researchers in this area, were able in a very carefully conducted experiment (1953), collecting tobacco products and then painting the skin three times a week with cigarette and tobacco tar, to produce cancer in mice. In their opinion, tobacco smoking had been experimentally proven as a cause of cancer. Critics immediately said that men are not mice, but it must be admitted that much medical research is based on animal experimentation.

The exact nature of the cancer-producing element or elements in tobacco tar is not known. Arsenic is present in tobacco smoke but it is questionable whether it is responsible for lung cancer. In all probability, there is a new undiscovered carcinogen (cause of cancer) or perhaps a number of carcinogens present in tobacco tar.

No proponent of the tobacco tar cause of cancer would deny that there are many other causes of cancer. It is common knowledge that more than 200 chemicals can cause cancer. The air pollution of our cities is undoubtedly a factor in lung cancer.

In his recently published book (1955), Dr. Wynder (41, *p. 107-110*) lists ten points which he believes suggest tobacco as *a cause of* lung cancer (not the only cause).

1. Lung cancer has increased sharply in those countries where a great increase in tobacco consumption, particularly cigarettes, has occurred. One exception is Iceland, which has a very low consumption of tobacco.
2. Predominant increase among males of lung cancer is compatible with the long-term smoking habits of the two sexes.
3. Slight increase of lung cancer in women is compatible with the increase in smoking among women some 10 to 20 years ago.
4. Predominant increase in lung cancer among urban population when compared with rural population is compatible with the greater cigarette consumption among city dwellers.
5. Peak of lung cancer deaths in the late 50's and early 60's is compatible with the introduction of some carcinogen 30 to 35 years ago. Increased cigarette consumption falls into this period.
6. Increase in the smoking habit, particularly of cigarettes considered with the latent period of cancer is compatible with the increase in sale of cigarettes. By itself, this factor means little. In addition to the other factors listed it is important, and, in the absence of an increase in cigarette consumption, tobacco could not be regarded as a major factor in the development of lung cancer.
7. Epidermoid cancer is rarely found in areas not exposed to extrinsic irritation. Certainly it cannot be denied that tobacco smoke serves as an irritant to the bronchial mucosa. The frequent history of chronic cough among long-term tobacco users points up this fact.
8. Clinical experience: The statistical tobacco data have not been surpirsing to clinicians who have had the opportunity of seeing many lung cancer patients and have taken detailed histories. Smoking histories have served well as an aid in differential diagnosis of lung conditions.

9. Tobacco is a proven animal carcinogen, with condensed cigarette smoke used to induce epidermoid cancer of the skin in nearly 50 per cent of the animals to which tar was applied.

10. No other plausible explanation for the statistical relationship. We can suggest no other feasible explanation for the statistical association found.

A few researchers still doubt the relationship of lung cancer and smoking. They believe the rise in lung cancer is primarily due to pollution of air with petroleum and coal tar derivatives and industrial contaminants. Hueper (17), who is a leading cancer environmental expert, is one of the eminent proponents of this theory. The statistical evidence for this view is not as good as for the cigarette theory, but the experimental evidence is stronger as many air pollutants have been shown repeatedly to be carcinogenic.

Undoubtedly a number of factors, each contributing singly or collectively, are factors in lung cancer. But for those individuals who still doubt the association between lung cancer and smoking, Dr. Wynder states (46):

"Those investigators who still doubt either the statistical or causative relationship between lung cancer and smoking must account for this established and clinical fact."

The American Cancer Society (41, *p. 109*), British Ministry of Health (12), and the Lung Conference at Louvain (3) sponsored by the World Health Organization, regard the correlation of smoking tobacco and lung cancer as established.

In 1953, the New England Journal of Medicine (27) in an editorial made this statement in regard to cigarette smoking and lung cancer.

"Present evidences of an association between cigarette smoking and lung cancer are so strong as to be considered proof within the everyday meaning of the word."

Dr. Snegireff (M.D.), professor of cancer control, Harvard School of Public Health, and Director of Cancer Control Unit at Cancer Research Institute, New England Deaconess Hospital, summarizes the most recent findings in the relationship of lung cancer and smoking (35).

1. Smoking is the leading important feature that the vast majority of the lung cancer patients have in common.

2. Cigarette smoking is by far *the most serious* of the causally related features which people with lung cancer have in common.

3. We consider that the causal relationship of cigarette smoking to the development of lung cancer to be real in patients who have their pathological processes proven by microscopic examination by pathologists with a wide experience in the recognition of cancer. I wish to emphasize that the causal relationship *is real* and *is not a statistical aberration.*

4. The impact of cigarette smoking on the development of lung cancer is the most important single cause which is common to all lung cancer patients, regardless of their social and economic status, and which is capable of explaining adequately the rapid rise of the lung cancer death rate in men.

5. We have confirmed the increased risk of the development of lung cancer in heavy smokers of cigarettes and find that previous reports of this fact are *not exaggerated, but are indeed conservative.* It is not a question of any risk from smoking but HOW GREAT is the RISK. Some individuals are more susceptible to the lung-cancer-producing effects of smoking and smoking half a pack of cigarettes may be as dangerous to them as smoking two packs is for others.

Death Rates Associated with Heart Diseases, Cancer, and Smoking

Heart diseases and cancer have increased tremendously in the last three decades. The incidence of heart diseases is currently 443 per 100,000 estimated population and cancer has a rate of 157 (38).

It is common knowledge that tobacco produces certain specific, measurable, physiologic reactions of the heart and circulatory system. The physiologic effects include increased heart rate, increased systolic and diastolic blood pressures, decrease in skin temperature at the extremities, and a constriction of blood vessels at the extremities (36). Electrocardiogram (13) and ballistocardiogram studies have further demonstrated that smoking effects on the heart and circulatory system can be measured (7).

Physicians have long advised heart patients to quit smoking or to reduce the consumption of tobacco. But the relationship, if any, of tobacco had not been clearly established. Obviously, smoking puts an additional strain on the heart, cumulative effects of which over the years could be an important factor in the disease.

The American Cancer Society's large follow-up study of almost 200,000 older men to find the relation between smoking habits and death rates found some startling results, especially in relationship to heart diseases (15).

Coronary heart disease is 51 per cent higher in heavy smokers and cancer incidence is 31 per cent higher. Cigar and/or pipe smokers were found to have a death rate only slightly higher (6%) than the average. If one has to smoke, cigars and/or pipe smoking apparently involves less risk than cigarette smoking.

In the opinion of Hammond and Horn, these facts, until some better proof is presented, prove an assocation between smoking habits and heart diseases and cancer (especially lung cancer).

Several earlier studies had found death rates to be higher among heavy smokers (23, 30). The heart disease and cigarette smoking association was overlooked by many, in the publicity that was given the American Cancer Society study. If the evidence continues to indicate the association, then more preventative action is imperative.

Tobbacco Industry Research Committee

The tobacco industry became so concerned with the relationship between lung cancer and cigarette smoking that it established a Tobacco Industry Research Committee which was announced January 4, 1954 (37). The committee made available an initial fund of $500,000 for research grants and pledged continuing finanial aid as the need develops. The program endeavors to produce clinical and experimental evidence regarding possible cause and effect relationship between smoking and lung cancer. No reports are yet available from this research program.

Summary and Conclusions

Seldom, if ever, is there universal agreement on a controversial medical and health issue. Medical history contains many examples of controversies similar to the present lung cancer-cigarette smoking controversy. Individual physicians and dentists are still opposed to fluoridation of water even though it has been approved for a number of years by both the American Medical Association and American Dental Association. Even Pasteur's germ theory of disease was opposed by some physicians and present-day physicians are not in universal agreement as to the best use of antibiotics and other new drugs.

Universal agreement of all medical authorities cannot be expected in the cigarette smoking and lung cancer controversy. Since 1950, there has been a steadily increasing number of physicians, medical and clinical researchers, and organizations who have accepted the association between lung cancer and cigarette smoking as real. Evidence of the association of lung cancer and cigarette smoking found in more than 15 independent studies is being accepted.

A few critics who still doubt the relationship of lung cancer and smoking include Dr. Heuper, an eminent environmental cancer researcher, and others. Their criticisms would seem to obscure rather than refute the findings, observed and reported in more than 15 independent studies throughout the world within the past six years. Those individuals who do not accept the cigarette smoking theory of lung cancer have not adequately explained why lung cancer is rare in non-smokers and why proven lung cancer cases are nearly always associated with long periods of heavy cigarette smoking.

Differences of opinion are healthy if they lead to additional research which will further scientific experiments and eventually find the answer for this complex problem. However, opinion differences can be harmful if small, insignificant, and unimportant criticisms, based on personal bias, result in public confusion and lead to continued poor health practices.

Cancer is still largely an unconquered disease and continues to baffle medical researchers. Until cancer is more completely understood, researchers are bound to have differences in opinions as to the fundamental causes. It is hoped that from this controversy will come future investigations that will find the undisputable answer to this question and other questions associated with longevity and health.

Health educators, naturally, should follow the advice and recommendations of the medical profession as to the individual preventative health measures that should be taught in the relationship of tobacco and certain disease conditions.

A study of the smoking habits of 4,171 New England physicians (35) published in April 1955, indicates the present opinions and advice of the physicians in this area. When asked whether they accepted the statement that "Heavy smoking of cigarettes may lead to lung cancer," 60 per cent

indicated they accepted the statement, with slightly more non-smoking physicians than smoking physicians indicating acceptance.

In this same study another surprising fact is found in the answers to the question "What advice were you giving patients about smoking?" Slightly more than one-third of the physicians indicated they were advising heavy cigarette smokers to stop smoking entirely while 61 per cent indicated they were advising heavy cigarette smokers to reduce the cigarettes smoked. So concerned were these physicians about the risk involved in cigarette smoking that 17 per cent had themselves quit smoking.

No previous study of this type had been made, but undoubtedly a large number of physicians have changed their opinions about the health implications of cigarette smoking in the last six years.

Individual preventative measures seem to be the only hope in reducing the alarmingly increasing lung cancer rate in males. Our youth need to be informed of the risk associated with cigarette smoking and the preventative measures of moderation in smoking habits, possible preventative action of filtered cigarettes and even elimination of the habit. Health educators have a responsibility, as does the medical profession, to give this information to their students and the general public.

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Development of Strength in High School Boys by Static Muscle Contractions

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Abstract

Two groups of students from the State University of Iowa High School were given four tests of strength at the beginning and again at the end of an eight-week period. Ten of the students were placed in the experiment group which was given exercises requiring static muscle contractions. One subject performed the exercises while his partner offered resistance; then they reversed roles. The members of the experiment group made gains significantly greater than those of the control group in the following: the back lift, the leg lift, and the combined hand grip tests.

UNTIL RECENT YEARS, the emphasis in strength development has been on the concentric-type of muscle contraction such as is used in weight training and/or weight lifting. In 1953, Th. Hettinger and E. A. Muller (2) published a report focusing attention on the effects of static-type contractions for the development of strength. They showed that one practice period per day in which the muscles were held in static contraction for a period of six seconds resulted in as much increase in strength as longer periods of muscle contraction (up to full exhaustion in 45 seconds) and more frequent practices (up to seven per day).

They believed that this increase in strength was associated with an insufficient supply of oxygen to the fiber. They were of the opinion that not all of the fibers were equally active until the training load reached about two-thirds of maximum, at which time all the fibers were lacking in oxygen supply. An increase in the training load beyond two-thirds of maximal strength had no further effect.

Increase in strength is explained by the *principle of overload.* A muscle develops in size and strength only as it is overloaded, that is, as it is required to exert force against greater resistance than it normally does (1). This development comes about by an increase in the cross-section of individual muscle fibers. (The number of fibers is fixed by heredity and, therefore, does not increase.)

The purpose of the present study was to determine the effect of static muscle contractions upon the strength of high school boys as measured by four strength tests.

Procedure

The samples for this study were drawn from the 11th and 12th grades of the University High School in Iowa City. Twenty students responded to a call for volunteers. They were told they were to participate in a study of strength, but had no prior knowledge of the testing and training program to be used for the experiment. This number was divided at random into two groups—ten in the experiment group, and ten in the control group. None was engaged in any special training during the time the study was in progress (no major sports, interscholastic competition, etc.). A constant check was made on the boys' daily regimen to make sure that there were no unusual circumstances to affect their performances.

At the beginning of the experiment, the two groups were given a battery of strength tests including the leg lift, back lift, left grip, right grip, and the Sargent Jump. The tests were given on the first day and again the next day in order to determine their reliability. The tests were administered according to the method described by McCloy (3). The tests were administered again eight weeks later at the conclusion of the experiment.

Calibration of the dynamometers used in this study was determined by suspending weights from the instruments and by checking the readings on the instruments with the weights. This was done prior to the initial tests and again prior to the final tests. In order to familiarize the subjects with the instruments, an explanation together with a demonstration was given to the two groups. The subjects were given three trials on the tests and the best score of the three was recorded.

The experiment group went through an eight-week training period to increase their strength by practicing a series of exercises that required static contractions of the muscles involved. The subjects met daily (at the same time each day, five days a week) for the training sessions. Since the success of the study was dependent upon the co-operation of the subjects, considerable attention was paid to motivating the boys to make an "all-out effort" in both the tests and the training exercises. Advantage was taken of the fact that boys of this age are greatly interested in strength and its effect upon physique.

An effort was made to select exercises that would develop the muscles measured by the strength tests. In performing an exercise, the muscle was held in static contraction for a period of six seconds once a day. The resistance for the exercise was offered by a partner who resisted the movement of the subject. The subjects worked in pairs, B supplying the resistance for A; then they reversed roles. Two of the exercises, one designed to develop the muscles that plantar flex the foot and the other to develop the muscles that

extend the forearm, are not illustrated, the other seven exercises are shown here:

FIGURE I. Exercise for Forearm Flexors and Extensors.

FIGURE II. Exercise for Leg Extensors.

FIGURE III. Exercise for Arm Flexors.

FIGURE IV. Exercise for Arm Abductors.

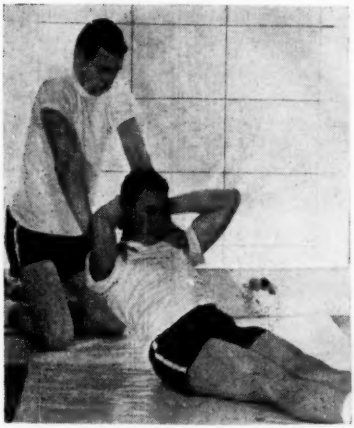

FIGURE V. Exercise for Trunk Flexors.

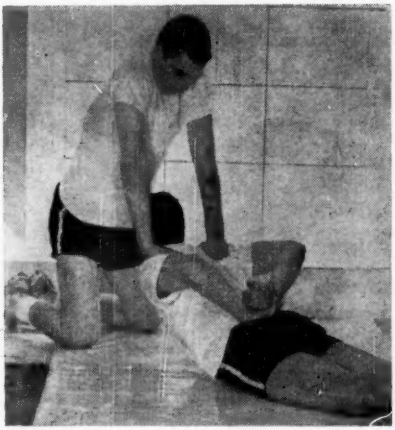

FIGURE VI. Exercise for Trunk Extensors.

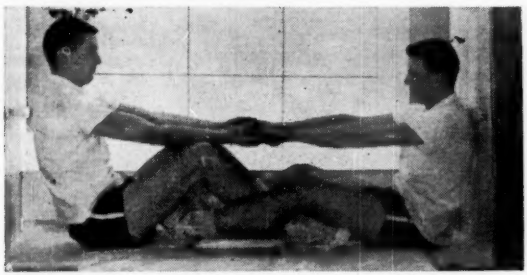

FIGURE VII. Exercise for Finger Flexors and Back Extensors.

Analysis of Data

The experiment group showed greater gains in all the items (except the Sargent jump) than did the control group. The *t* test for small independent random samples given by Linquist (4) was used to determine the significance of the differences between the mean gains made by the experiment group and the mean gains made by the control group. The *t*'s and the levels of statistical significance for the four tests are shown in Table 1. The differences between the mean of the gain scores (difference between initial and final scores) of the experiment group and the mean of the gain scores of the control group for the back lift, and for the leg lift were significant at the one per cent level, combined hand grips were significant at the five per cent level. An increase in leg strength would normally result in a better performance on the Sargent jump, however, the amount of strength developed

by the individuals in this study was not great enough to bring about a significant gain.

TABLE 1
Significance of Differences Between Mean Gains

Test	Control Group Mean Gain	Experiment Group Mean Gain	t	p
1. Back lift	17.00	82.50	3.80	.01
2. Leg lift	28.50	207.00	2.23	.05
3. Combined grips	2.40	11.30	2.45	.05
4. Sargent jump	.20	.70	1.72	.10

Summary and Conclusions

Two groups of students from the State University of Iowa's High School served as subjects to determine whether static muscle contractions would result in significant changes in strength. Four tests of strength were administered at the beginning and at the end of an eight-week period. The *t* test was used to determine the significance of the differences between the mean gains of the two groups. The experiment group made greater gains in the back lift, the leg lift, and the combined hand grip test than did the control group. These gains were statistically significant.

It is concluded that, for the muscle groups tested in this experiment, static muscle contractions of six seconds' duration will cause significant gains in strength. The increases in leg strengths made by the members of the experiment group were not proportionately great enough to produce a statistically significant gain in the Sargent jump.

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Notes & Comments

Job Analysis of the Duties of Athletic Directors

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THE PURPOSE OF the study was to determine the duties of athletic directors and to evaluate these duties in terms of frequency, importance, and difficulty of performance in institutions of different sizes. The study further proposed to determine which duties are characteristically practiced by successful athletic directors. Four steps were used to accomplish these purposes.

1. To discover the duties of directors in selected colleges and universities.
2. To analyze these duties in institutions of various sizes in respect to their frequency, importance, and difficulty of their performance.
3. To develop criteria by which excellence of athletic departments may be judged.
4. To analyze, with reference to these criteria, the practices of selected athletic directors which make their departments superior.

A master list of the duties performed by athletic directors was developed in questionnaire form. These duties were divided into six major categories of duties essential to administrating an athletic department. The categories were:

1. Miscellaneous administrative duties.
2. Financial duties.
3. Duties relating to property and equipment.
4. Public relations duties.
5. Duties relating to coaches and contests.
6. Duties relating to athletes

Two groups of directors comprising a total of 157 subjects completed the questionnaire. One group was made up of 110 athletic directors in institutions ranging in size from under 1,000 to over 10,000 enrollment and located in all geographical sections of the United States. Seventy-nine directors in this group responded to the questionnaire. The second group of 90 directors, also in schools of all sizes and locations, represented specific athletic conferences. It was from this group that a jury of experts was selected. Seventy-eight directors in this group answered the questionnaire.

The lists of duties of athletic directors were rated on the basis of frequency, importance, and difficulty of performance. Decile scores were computed from these ratings for each of these factors for five groups of schools classified according to size. The decile scores were used to analyze the duties of athletic directors.

Twenty-three directors in the 90 schools in the specified conferences were selected by their colleagues as being superior practitioners. This group made up the jury of experts. The jury evaluated a prepared list of criteria for successful management of an athletic program. They were also invited to suggest other criteria. Their suggestions resulted in a second list of criteria which served to substantiate items in the original list as well as to reveal other bases of judgment.

Placing the criteria of the two lists into a single ranked list was not feasible, since the two lists were the result of entirely different procedures. However, analysis of the two lists revealed that successful athletic directors were more concerned with duties in the areas of financial soundness, department organization, personnel matters, public relations, and care of property and equipment.

The criteria of success were utilized to discover what superior directors do which makes them, in the opinion of colleagues in their conferences, outstanding practitioners.

This was accomplished by listing under each criterion of success the duties essential to the accomplishment of that criterion. The duties which were rated with decile scores of eight, nine, or ten were considered the most important duties performed by the directors. Forty-seven such duties were revealed. The greatest number of duties appeared in the category of miscellaneous administrative matters. This was followed in order by the duties involving finances, care of property and equipment, public relations, duties relating to coaches and contests, and duties relating to athletes.

Other major conclusions were revealed by the study, in addition to the duties of athletic directors and the criteria for success of athletic department administration.

The master list of duties was regarded sufficiently comprehensive to include most of the multitude of duties performed by directors. The questionnaire might be useful as a checklist for those interested in a career as an athletic director, as a self-evaluation checklist, and to analyze the athletic department in light of frequency, importance, and difficulty of the duties involved in athletic administration.

A wide variety of factors influenced the work of the director. These factors were the size of the institution, the number of employees in the department, the talents of the employees, the scope of the athletic program, the responsibilties of the director, the delegation of duties, responsibility for facilities, and rules and regulations of the conference.

The total number of high decile ratings of the jury of superior directors ranked the categories of duties in the following order: administrative duties, public relations, finances, coaches and contests duties, property and equipment duties, and duties relating to athletes.

The greatest differences in administering athletic departments occurred in institutions with enrollments under 2,500 students. Directors in smaller schools were more concerned with the details of various duties, while their colleagues in larger schools were able to delegate such duties to members of their larger staffs.

The principal supplementary duty performed by directors was to act as the head of the physical education department. This combination occurred most often in smaller schools. Coaching and teaching were next in order of greatest occurrence. As the size of the school increased there were fewer supplementary duties performed by athletic directors. It was revealed that in smaller schools the director was responsible for one to three extra duties—in addition to those of director.

The types of employees supervised by the directors were in five principal areas: staff personnel, coaches, office personnel, public relations directors, and maintenance personnel.

On the average, it was shown, directors can expect to work approximately 51 hours a week in performing the duties of the directorship.

Accident Experience with Trampolines

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IN THIS SURVEY, 171 questionnaires were sent to purchasers of trampolines who had obtained their apparatus at least five years prior to this investigation.[1] Questions were asked concerning the nature and severity of the injuries, the frequency of injury, and the conditions under which the injuries occurred. Instructors were requested to indicate

[1]A copy of the questionnaire can be obtained from the writer upon request.

whether or not they considered trampolining a good physical education class activity and why they answered as they did. They also stated the ages for which they considered trampolining suitable. Of the 132 responses (77%), 16 were eliminated because of limited use of the trampoline. Participants in the study include schools and other institutions for various age levels, and private owners who conduct trampoline classes.[2]

Table 1 presents the number of injuries of differing degrees of severity based on the length of recovery periods. A total of 167 injuries was reported, 74, or 44 per cent of which required one week or less for recovery. The latter injuries were predominantly minor abrasions or muscular strains. Therefore, only those requiring longer than one week for recovery were considered serious and were included when relating injuries to amount of participation.

In elementary schools, the trampoline was used an average of 5.9 years. The mean number of student-hours during which one serious injury occurred was 6,335. This might be considered the equivalent of one injury in 8.4 weeks of five daily classes having enrollments of 30 students each. Similarly, the high schools, which had used the trampoline a mean of 5.3 years, averaged one injury in 12,229 student hours, the equivalent of one in 16.3 weeks.

Injuries in colleges occurred more frequently, their average being one in 7.6 weeks during a mean of six years of use. The YMCA's reported six serious injuries during an average of 5.5 years, and the turnvereins, one in 6.5 years. No serious injuries occurred in the boys' club, the park district, or the school for the deaf. The average years of trampolining in these institutions was seven, six, and five respectively. The school for the blind and the gym club reported no injuries during their one year of trampolining.

The type of injury occurring most frequently in elementary schools was a strained back, which accounted for 16 of the 25 injuries. While most of these lasted from one day to one week, three required three weeks for recovery. Thirteen of those injured were performing a front drop. The longest recovery period for injuries to elementary school children was six weeks, the time for recovery of a broken leg and a broken ankle.

Seventy-one injuries occurred in the 55 high schools during an average of 5.3 years. One injury resulted in a permanently stiff neck. Two other injuries, while not having any lasting effects, had longer recovery periods. One of these, sustained by a 15 year-old boy, was a broken neck which required one year for recovery. The performer had had no lessons in trampolining, was unsupervised, and no one was guarding. The other injury, a compound fracture of the tibia, required a nine-month recovery period. The injured, a 16-year-old student, was noted as a heavy girl who had a history of breaks. In high schools, back and neck injuries were more frequent than injury to any other part of the body.

Several injuries to high school students were attributed to seemingly avoidable circumstances. Two injuries occurred when the trampoline was left up and unguarded, another when the canvas ripped, and four because of old injuries or weaknesses. Five other injuries were noted as resulting from inexperience. The latter cause would seem to indicate a need for greater concern for individual readiness or progress.

Colleges and universities had a total of 40 injuries during an average of six years of use of the trampoline. A serious injury to a 25-year-old student resulted in paralysis from the waist down. This unsupervised student was doing a back somersault when he suffered a spinal fracture, the cause of which was noted as "carelessness."

One instructor incurred a permanently bad knee; another, a foot injury which required a year for recovery and which resulted in continued soreness. Two college students sustained back injuries, one requiring a year for recovery and the other six months. All four of these injuries occurred when the performers were bouncing, and all landings were made on the bed of the trampoline. Another student, while doing flips, fractured a vertebral process which required six months for recovery. There were no guards attend-

[2]Experience with trampolines by the United States Armed Services was not included in this study, since the information available was limited.

TABLE 1
Number of Injuries of Different Recovery Periods

Number and Type of Owner	No Recovery Given	1 day to 8 days	8 days to 3 wks.	3 wk. to 6 wk.	6 wk. to 3 mo.	3 mo. to 6 mo.	6 mo. to 9 mo.	1 yr.	over 1 yr.	Totals
10 Elem. Schools		16	6	3						25
55 High Schools	10	29	14	4	9	3	1	1		71
21 Colleges-Univ.		11	10	9	3	3		2	2 yr. *never	40
15 YMCA's	1	5	4	1		1				12
4 Turnvereins		6	1							7
3 Boys' Clubs		3								3
1 Park Dist.		1							18 mo.	1
4 Private Owners		3	1	1					2 yr. 6 yr.	8
3 Educ. of Deaf; 1 Educ. of Blind; 1 Gymnastic Club—No Injuries										
116 Total	11	74	36	18	12	7	1	3	5	167

*This injury resulted in a "permanently bad knee."

ing, and the student was unsupervised. Injury to the legs occurred more frequently in college trampolining than did injury to other body areas.

Twelve injuries were reported by the 15 YMCA's which had used the trampoline an average of five and one-half years. The only permanent effects reported were the loss of one tooth by one boy and two teeth by another. The latter performer was unsupervised and not attended by guards.

The most serious injury reported by turnvereins was a wrenched back which required two weeks for recovery. The three boys' clubs or homes had used the trampoline for an average of seven years. They reported three minor injuries. The park district reported one minor laceration in six years of usage with year-round classes having enrollments ranging from 25 to 48. No injuries occurred in the school for the deaf which had used a trampoline for five years, an average of two hours weekly for classes of 15 students. The school for the blind which had used a trampoline weekly for one year also had a record of no injuries.

One of the individual owners of trampolines reported that a performer injured a lumbar vertebrae to the extent that six years were needed for recovery. This injury occurred when the back was overarched during a knee-drop. In another instance, two years were required for recovery of a fractured cervical vertebrae incurred when a stage floor gave way. A similar injury was sustained during the performance of a back somersault and resulted in limited rotation of the head.

Another individual owner reported that only two minor injuries occurred in two years. His trampoline was used 27 hours each week. Two other individual owners who had used a trampoline for eight years and for three years, respectively, had no injuries.

In 100 accidents (60% of the total in the study) the performer landed on the bed; in 34 (20.5%) he struck the frame; in 12, the springs were involved; and in 11, the performer hit the floor.

No instructor was supervising when 39 injuries (23.35%) occurred. Forty-one injuries (24.5%) occurred when fewer than four persons were guarding.

Instructors most frequently named the following causes of injury: inexperience, off-balance, relaxed landing, and poor timing.

While three instructors thought the trampoline dangerous, 98 were enthusiastically favorable toward it. Among 30 outcomes claimed, the most frequently named were: coordination, balance, conditioning, rhythmic response, muscular strength, confidence, control, and courage.

In schools and colleges, injuries increased in severity as age level advanced. Based on number of hours of participation, injuries occurred twice as frequently in colleges as they did in high schools. Advanced stunts attempted by college students were probably more conducive to injury. Also in colleges, students were more often unsupervised and more frequently attended by fewer than four guards than was true elsewhere.

It is recommended that studies be conducted to ascertain the contributions of trampolining to the outcomes claimed, and to investigate the effects of rotating mat tumbling and trampolining.

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Research Abstracts

Prepared by the Research Abstracts Committee of the National Council of the Research Section, PAUL A. HUNSICKER, Chairman

Anatomy and Physiology

50. BENNETT, A. L., *et al.* A manual method of artificial respiration for the simultaneous resuscitation of two victims. *Jour. of Applied Physiol.* **8**: 603-607 (May 1956).

A manual method by which one operator can effectively apply artificial respiration simultaneously to two victims is presented. The tidal exchange was calculated on 178 tests involving 16 selected subjects. The double method was found to be nearly as effective as the single method of Holger Nielsen.—*Paul Hunsicker.*

51. BILOWIT, DAVID. Establishing physical objectives in the rehabilitation of patients with Parkinson's disease. *Phys. Ther. Rev.*, **36**: 176-178 (March 1956).

From clinical experience, a new technic in the physical rehabilitation of patients with Parkinson's disease was evolved in accordance with these basic principles: (1) The establishment of a physical objective for each motion, and (2) The establishment of a rhythmic pattern of movement to attain timing. Punching the speed bag, stair climbing, throwing, catching, kicking a volleyball or soccer ball are recommended activities.—*Paul Hunsicker.*

52. EICHORN, DOROTHY H. A comparison of laboratory determination and Wetzel Grid estimates of basal metabolism among adolescents. *J. Pediat.*, **46**: 146-154 (1955).

Longitudinal determination of basal metabolism made by the Tissot open-circuit technique were compared with the Wetzel Grid estimates of total calories per day for 52 boys and 52 girls between 11.5 and 17.5 years. It is suggested that a maturity referent be included in standards for basal metabolism during adolescence.—*Psychological Abstracts.*

53. HENRY, FRANKLIN. Effects of exercise and altitude on the growth and decay of aviator's bends. *Jour. of Aviat. Med.*, **27**: 250-259 (June 1956).

Reference is made to selected publications dealing with aviator's decompression sickness. Pain rate curves are presented which are based on data secured from subjects in a decompression chamber at various altitudes and after taking different amounts of exercise.

Altitude is found to be quantitatively a more important variable than muscular exercise. Although the latter influences the total incidence of bends, its largest effect is the causing of earlier appearance and earlier regression of symptoms.—*Paul Hunsicker.*

54. JONES, RICHARD J., M.D. Serum cholesterol reduction in patients by the oral administration of a brain extract. *Journal of Laboratory and Clinical Medicine*, Feb. 1956, p. 261.

Because of the possible relationship between atherosclerosis and levels of cholesterol in the serum, the interesting implications of being able to control the latter are obvious. A number of substances have been found—notably soya sterols—which significantly reduce serum cholesterol. In the present study, the influence of a cerebroside fraction of beef brain was observed in 9 subjects with coronary artery disease and hypercholesterolemia, the experimental periods running three to eight weeks. In all patients there was a drop in the levels of serum cholesterol during the experimental period. At the same time lesser reductions, though significant, were noted in phospholip, neutral fat, and beta lipoprotein. Alpha lipoprotein, however, was not significantly affected. In a single normal subject, serum cholesterol levels apparently were not influenced.—*Medical Abstract Service.*

55. KROGMAN, WILTON MARION. Biological growth as it may affect pupils' success. *Merrill-Palmer Quart.*, **1**: 90-98 (Spring 1955).

The general thesis is that there is a positive relationship between rate of progress in physical growth and rate of progress in social, intellectual, and emotional maturity. The mechanism underlying this relationship is described in terms of an individual's response to his own concept of the acceptability of his growth pattern. Three organic growth factors which may exert a profound influence on individual behavior are: (1) the size factor which pertains mainly to height and weight as determined by family line or ethnic background; (2) the timing factor which is related to rate of maturation; and (3) the aesthetic-harmony factor which refers to a balance or blend in growth.—*Psychological Abstracts.*

56. MONGE, C., *et al.* A description of the circulatory dynamics in the heart and lungs of people at sea level and at high altitude by means of the dye dilution technique. *Acta Physiologica Latina Americana*, **5**: 198-210 (1955).

Determinations of circulation time, cardiac output, intra-thoracic blood volume, central volume and total blood volume were made on 20 males and 15 females at sea level and on 10 males at 14,900 feet altitude. When values are corrected per square meter of body surface area, they do not differ greatly between males and females at sea level, aside from the well-known hematological differences. The high altitude male native group shows longer circulation time, slightly greater cardiac output, greater blood volume, and greater quantity of blood in the lungs. When the amount of blood in the lungs, as calculated by Newman's formula is expressed as a percentage of total blood volume, the high altitude group also shows a higher figure over the sea level group.—*Paul Hunsicker.*

57. PADGET, DORCAS HAGER, The cranial venous system in man in reference to development, adult configuration, and relation to the arteries. *Am. J. Anat.*, **98**: 3 (1956).

A summary of detailed studies of venous development is presented. Vascular "cleavage" applies only to dural and pial layers; cutaneous (scalp) plexuses are separately derived from the secondary external jugular (and carotid) systems. Adult venous configuration is seldom completed at birth; anastomoses thereafter permit sinuses other than the sigmoid to drain the brain. A lateral mesencephalic vein may drain the basal vein into the superior petrosal sinus. Primarily both the superior sagittal and straight sinuses drain chiefly to the right; formation of the secondary left innominate vein tends to equalize torcular drainage bilaterally, but a related asymmetry in both regions is common in man. The relation of pial veins to arteries is significant while both are still endothelial tubes: the veins cross subjacently and at right angles to the more numerous arteries, formed earlier from the capillary net. A fistula between embryologically choroidal vessels draining into the Galenic vein is a much more common type of congenital AV aneurysm than generally realized. Prenatally such a fistula may result in flow disturbances to adjacent superficial vessels, which spread during the subsequent cerebral and cerebellar expansion. This arterial influx may involve dural, cranial and/or extracranial vessels. However, such secondary dilatations may be cut off from their primary connections during subsequent prenatal development, which includes major venous shifts; this may result in various telangiectases or chiefly venous aggregations.—*The Wistar Institute.*

58. REISER, MORTON F., *et al.* Effect of variations in laboratory procedure and experimenter upon the ballistocardiogram, blood pressure, and heart rate in healthy young men. *Psychosom. Med.*, **17**: 185-199 (1955).

Physiological measures recorded in experimental and control settings indicated that "differences in experimenter-subject relationship may alter the total meaning of the situation so that different psychological and physiological mechanisms of response are evoked by an otherwise identical test procedure." Results are discussed in relation to the problem of specificity of affective response. There are 21 references.—*Psychological Abstracts.*

59. Simonson, E., and Ancel Keys. The electrocardiographic exercise test: changes in the scalar ECG and in the mean spatial QRS and T vectors in two types of exercise; effect of absolute and relative body weight and comment on normal standards. *Amer. Heart Jour.*, **52**: 83-105 (July 1956).

Moderate exercise produced statistically significant changes of most ECG items in 91 middle-aged normal men. Upper and lower limits of the changes of mean spatial QRS and T vectors are presented for both types of exercise for 95 per cent of a population of healthy older men, of which this group is a representative sample.

There were significant differences in the post-exercise changes of several conventional and vectorial electrocardiographic items between an overweight and an underweight group, but the effect of relative body weight on the exercise ECG was less pronounced than the effect on the resting ECG.

The validity of normal standards for the exercise tolerance test is critically discussed.—*Paul Hunsicker.*

60. Sobel, Edna H., M.D. The use of methyltestosterone to stimulate growth: relative influence on skeletal maturation and linear growth. *Journal of Clinical Endocrinology and Metabolism*, Feb. 1956, p. 241.

Although testosterone stimulates growth it also tends to increase the skeletal maturation rate. Since growth of long bones stops when epiphyseal fusion is complete, justification (or lack of it) for use of testosterone to promote growth in children of short stature must be sought in the answer to the question: Under testosterone therapy does skeletal maturation advance more rapidly than the accelerated linear growth? If skeletal maturation is more rapid, then ultimate stature may be expected to be decreased rather than increased. To throw some light on this question, 27 slow-growing children, aged 5½ to 12 years, were evaluated over a period of two years. Duration of therapy was six months, during which time methyltestosterone, 5 to 40 milligrams daily, was given orally. During the six months in which hormone was given it was found that a dose of 5 mg. daily evoked a growth response equal to the larger doses. During the treatment period average increase in skeletal age was greater than increase in height age, and after stopping therapy, skeletal maturation continued to advance at greater than the control rate. At the same time, growth increments reverted to average normal when methyltestosterone was stopped. In the 24 months, bone-age and height-age increments were about equal in 40 per cent of the children, but 56 per cent showed a greater increase in bone-age than height-age. The disproportion between the two rates was noted in some of the children in each dosage group. The implication is that testosterone "may not be a suitable agent for the promotion of growth."—*Medical Abstract Service.*

61. Strandberg, B. The incidence of atelectasis after heart operations with and without breathing exercises. *Annals of Phys. Med.*, **3**: 18-20 (Jan. 1956).

Between 1948 and 1949 33 out of 91 patients on whom cardiac operation had been performed developed post-operative atelectasis, from which five died. Between 1951 and 1952, when pre- and post-operative breathing exercises were given the patients only five out of 97 developed post-operative atelectasis and none died.—*Paul Hunsicker.*

62. Wilson, R. H., *et al.* An evaluation of the single breath technique for measuring anatomic respiratory dead space with the nitrogen meter. *Amer. Jour. of Med. Sci.*, **232**: 67-75 (July 1956).

A new geometric and mathematical method for estimating anatomic dead space from the nitrogen meter single breath curves is presented. Determinations were made on 63 subjects, ranging from 12 to 63 years in age. The new method produces anatomic dead space values equal to those calculated with the Bohr formula and a formula for a model with known dead space values. Hyperventilation with or without additional exercise leads to an increase in anatomic dead space. It decreases in changing from the sitting to the supine position.—*Paul Hunsicker.*

Nutrition

63. FRANK, R. M., and F. A. JOHNSTON. Total energy needs of women 22 to 36 years old. *J. Amer. Dietetic Assoc.*, **31**: 1007-1009 (1955).

Eight women in whom basal metabolic rate was within normal limits were weighed at intervals during four months. They were allowed to vary their consumption of such foods as cream, butter and sugar so as to adjust energy intake to needs. In this way it was hoped that the women would maintain body weight. In fact, some lost and some gained weight. The average intake was 2140 cal. Corrected for weight loss or gain this gave a requirement of 2215 cal., in good agreement with the requirement of 2270 cal. predicted from U. S. National Research Council (1953) standards (Abst. 3538, Vol. 24).—*Nutrition Abstracts & Reviews.*

64. FRANKE, K. Sport und neuzeitlicke Ernahrungspraxis. (Sport and modern nutrition practice.) *Deutsch. med. Wochenschr.*, **80**: 1813-1814 (1955).

After a discussion of the needs of different types of athletes, the following recommendations are made: not too much to eat, and especially not too much fat; part replacement of meat by milk products (curds, cheese, milk beverages, and sour milk) and whole grain cereals; fruit and salads instead of soup; fat mainly as butter or as vegetable oils or high-grade margarine containing the essential unsaturated fatty acids; mild herb or yeast flavorings rather than too much salt and pepper; and for young people, fruit juice and milk beverages instead of tobacco, alcohol, coffee, and kola.—*Nutrition Abstracts & Reviews.*

65. HAMMOND, W. H. Measurement and interpretation of subcutaneous fat, with norms for children and young adult males. *Brit. J. Prev. Social Med.*, **9**: 201-211 (1955).

Skin-fold thickness was measured with the Medical Research Council calipers and also with the modified Franzen calipers (Abst. 5545, Vol. 25). Joint trials were made by three observers to insure that their standards were comparable. The subjects, just over 4,500 in number, were in 6 groups including ages from infants to adult women, different social classes and a group of debilitated children. Measurements from 16 different sites were well correlated; correlations between single sites and total fat were of the order 0.8 to 0.9; 2 sites usually gave multiple correlations of the order of 0.95, and 3 sites 0.97 or better.

Sub-scapular and abdominal measurements followed by biceps and either sub-costal or supra-iliac measurements gave the best indication of total fat. In two studies on children the changes at 5 or 6 different sites were followed for 24 months. It was found to be more important in such studies to use several sites. The 6 sites finally selected were biceps, triceps, sub-capular, supra-iliac, subcostal and abdominal (umbilical region).

Age trends at the different sites are tabulated for both sexes and ages from 2 years upwards. In girls there was a slight decrease in fat on all sites from 2 to about 5 years, then a continuous increase to 15 years, when the data stop. In boys the trunk fat decreased from 2 to 7 years, then increased rapidly to 11 years and more slowly to 17. The arm fat in boys decreased until 8 years, rose slowly to 11 and then fell, first slowly and then steeply, to 18 years of age.

A scatter diagram shows the relation between caliper measurements and measurements of subcutaneous fat thickness from X-ray photographs. Correlations were from 0.82 to 0.90, depending on site and sex. Mean measurements for different nutritional and social groups deccended from good to poor nutrition and from high to low social class, but there was no social gradient in body fat comparable with those in height and weight.—*Nutrition Abstracts & Reviews.*

66. KEYS, A., *et al.* Weight gain from simple overeating. 1. Character of the tissue gained. *Metabolism*, **4**: 427-432 (1955).

Twenty men were induced to overeat for 6 months with constant activity. Mean weight was 10.6 kg. The tissue mass gained was estimated to be 13 to 15 per cent extracellular fluid, 61 to 64 per cent fat, 0 to 1 per cent glycogen and the remainder cells. The composition of the tissue was independent of the weight gained over the range 2.5 to 22.3 kg. The percentage of cells was lower, and that of fat higher, than was previously estimated in tissue gained by men re-fed after prolonged severe undernutrition.—*Nutrition Abstracts & Reviews.*

Miscellaneous

67. BECK, H. S. Present status of physical education in special classes for the educable mentally handicapped. *Amer. Jour. of Ment. Def.*, **61**: 117-120 (July 1956).

A questionnaire was sent to the 62 school districts in Illinois having special classes for educable mentally handicapped children. The following conclusions were drawn from the 60 districts that responded: (1) Physical education is important for educable mentally handicapped children; (2) The schools are not doing formal research in this area; (3) The schools feel a need for research in this area; (4) Although objectives are more or less agreed upon, the means of attaining them are not; and (5) The objective of preparing the child for leisure-time activity has been largely overlooked or ignored.—*Paul Hunsicker.*

68. DVORAK, EARL A. Research experience—key indicator of quality of doctoral candidate? *Peabody J. Educ.*, **33**: 82-85 (1955).

Advisers of research studies can early determine the quality of their charges. By this is meant their intellectual level as well as character and personality traits. Period of time involved and individual attention necessary are major factors. The author sets forth six questions which the adviser may ask himself, and then discusses each. They are: (1) What type of research problem does the candidate undertake? (2) Can he work without constant supervision? (3) Does he produce his best, or is he satisfied with something less? (4) Does he maintain perspective in times of stress and strain? (5) Does he admit his mistakes and shortcomings? (6) Is he humble about his accomplishments? Answers to these provide ready reference for predicting achievement beyond the doctorate.—*Psychological Abstracts.*

CORRECTION

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(Vol. 26, No. 1, p. 119)

Statement No. 26 is missing. It should read: "26. By the time a person has acquired a skill, he has less emotional self-control than before."

—Carl Wear, University of Nebraska

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Robert A. Turner, West Point Manufacturing Company, West Point, Ga.
Thelma Bishop, Michigan State University, East Lansing.
Ernest V. Blohm, 130 Mason Building, Lansing 26, Mich.
William J. Tait, Florida State University, Tallahassee.
Cecil W. Morgan, United Cerebral Palsy, 369 Lexington Ave., New York City.
Robert Boyd, VA Hospital, Downey, Ill.
Gladys L. Brown, YWCA National Board, 600 Lexington Ave., New York City.
Edward W. Pastore, Boys' Club of America, 381 Fourth Ave., New York City.

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Iowa (3)
Kansas (2)
Minnesota (5)
Missouri (3)
Nebraska (2)
North Dakota (1)
South Dakota (2)
Wyoming (1)

Eastern District

Connecticut (3)
Delaware (1)
D. C. (2)
Maine (1)
Maryland (3)
Massachusetts (4)
New Hampshire (1)
New Jersey (4)
New York (10)
Pennsylvania (5)
Rhode Island (2)
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Indiana (4)
Michigan (5)
Ohio (5)
West Virginia (2)
Wisconsin (3)

Northwest District

Idaho (1)
Montana (1)
Oregon (2)
Washington (3)

Southern District

Alabama (2)
Arkansas (1)
Florida (4)
Georgia (3)
Kentucky (2)
Louisiana (3)
Mississippi (2)
North Carolina (3)
Oklahoma (2)
South Carolina (2)
Tennessee (2)
Texas (6)
Virginia (3)

Southwest District

Arizona (2)
California (7)
Nevada (1)
New Mexico (2)
Utah (2)

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American Academy of Physical Education.
American School Health Association.
American Youth Hostels, Inc.
Association for Physical and Mental Rehabilitation.
Boys' Club of America, Inc.
Canadian Association for Health, Physical Education, and Recreation.
College Physical Education Association.
Delta Psi Kappa
National Association of Intercollegiate Athletics.
National Association for Physical Education of College Women.
National Board of the YWCA of the United States.
National Collegiate Athletic Association.
Phi Delta Pi.
Phi Epsilon Kappa.
Physical and Health Education Section, National Association of Jewish Center Workers.
Physical Education Society of the YMCA's of North America.
Society of State Directors of Health, Physical Education, and Recreation.

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